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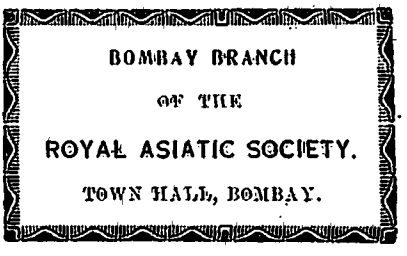

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FOREST RESEARCH IN INDIA, 1932-33.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

The immediate value of investigations has received special attention during the year. Not only was this necessary in view of the restriction of the programme imposed by economy, but without close consideration of immediate requirements there is fear of divorcing research, for which there is such vast scope, from practical forestry. Every effort has been made to ascertain and to take up the problems of most importance to the forest departments in the provinces, and problems of growing timber and other produce and of utilising what is available, have been selected with this object in view. A detailed programme of work in each of the branches for the three years 1933-36 was also drawn up at the Institute and sent to the provinces for suggestions. This programme, as finally modified, and a short descriptive guide to the Institute have been issued since the close of period under review.

In the Silviculture Branch, both Statistical and Experimental Sections record effective action on several important items of their programmes. A feature of the year is the close co-operation of the provinces and the Research Institute on several lines of investigation, such as the relative value of teak seed from different parts of its range for use in given localities, the study of *sal*(*shorea robusta*)regeneration and management problems over the whole geographical range of the species, the initiation of experiments with modern technique for the best management of bamboo, problems connected with irrigated plantations in canal colonies, and the collection of routine and special data for the compilation of multiple yield tables for deodar. The completion of these deodar tables with separate data for four grades of thinning, provisional as they inevitably are from the nature of the data, marks an important step forward as they are the first of their kind, and provide a fitting conclusion to the valuable work done at the Research Institute by the Statistical Assistant, Mr. Mahendru, whose period of deputation has now ended. Yield tables for *banj* oak (*Quercus incana*), a species which does not lay down annual rings in its timber enabling age to be determined, were also virtually completed before he left, and will, it is believed, be the first published solution of a

problem of this kind. Useful progress was made in finding practical means of measuring the volume of standing trees with sufficient accuracy for research work, a problem which is at present receiving much attention in many countries. Tables giving average volumes of trees of given dimensions were prepared for three leading matchwood species for which data were required. Experimental work continued on the existing lines; several investigations have reached a stage at which definite conclusions should be obtainable, but for various reasons, it has not been possible to complete the compilation and checking work. In addition to the teak seed origin experiment referred to, similar tests have been made with several other trees and some of them are giving positive results, though it is necessary to wait some years before it will be safe to draw conclusions and before data will be available on all the necessary points. Experiments on the effect of burning *sal* (*Shorea robusta*) plantations, and on the storage of root and shoot cuttings before planting have, among others, given interesting results. All available information on two subjects of far reaching importance was collected and published as a basis for current procedure and further research. These were the question of the advisability of raising teak in pure plantations, and the importance of the origin of seed used in plantations. With a view to preparing a similar survey of *sal* regeneration and management, an extensive tour in six provinces was organised to enable the Silviculturist to meet and discuss problems in representative forests with officers with special experience: the resultant report will, it is hoped, satisfactorily meet a much felt need.

Nearly eight hundred specimens were identified by the Forest Botanist during the year, and the description of grasses to complete Duthie's Flora of the Upper Gangetic Plain was continued by Mr. R. N. Parker. 3,376 sheets were added to the herbarium and numerous additions made to the arboretum and fruticetum. A simple illustrated handbook of 40 common Indian trees will issue shortly to meet the requirements of educational institutions and the general public. In the Mycological Section the root disease of *shisham* (*Dalbergia sissoo*), the dying back of *Gmelina arborea* and the damping off of seedlings in nurseries were studied. Results of inoculation with *Peridermium himalayense* and an outline of the control measures suggested will be published shortly.

Considerable progress was made in the identification of the insect fauna of sandal; eleven out of the thirty-five specialists who are collaborating with the Entomological Branch of the Institute furnished reports. Much ground has been covered in the search for a vector of spike disease and a large number of transmission experiments have been conducted; symptoms resembling spike have been produced by four species of insects, and since the close of the year a more definite indication has been reported. The problem of preventing borer attack on bamboos by felling at suitable seasons, and by treatment with suitable antiseptics,

has been solved. The myth about the effect of the moon's phases on liability to damage has been scientifically disproved. The safest period to fell bamboos at Dehra Dun is at the end of the hot weather and in the first month of the monsoon, and the next best period is from the end of the monsoon to the beginning of the cold weather. The study of natural factors controlling teak defoliators has progressed far enough to establish the principles of biological control in plantations, and the control of secondary borers of *sal* (*Shorea robusta*), which become important where *Hoplocerambyx* is kept in check, has been investigated. Some 36,000 insects, mainly timber borers, have been bred in the insectary and hundreds of specimens, including 300 new species, have been added to the collection. Twenty-five publications were issued or sent to the press.

The economic side of Indian forestry marks a great advance with the publication of the manual *Commercial Timbers of India* by Sir Ralph Pearson, formerly Forest Economist at the Forest Research Institute, and Professor H. P. Brown of Syracuse University, U. S. A., who for some time worked at the Forest Research Institute. This manual deals with the anatomical characteristics, identification, distribution, strength, seasoning, durability, working qualities, uses, and supplies of 320 timbers selected from among some 2,500 varieties that grow in the forests of India.

In the Economic Branch of the Institute economy was effected by restricting large scale experiments so far as possible. Four hundred samples of wood were identified in the Wood Technology Section, and a key to the important timbers of the Punjab is nearly complete. Valuable additions were made to the authentic collections of wood specimens and of photomicrographs.

A large number of mechanical tests and shrinkage and physical determinations were made in the Timber Testing Section. An important addition to the programme of work was the testing of glue joints made by the ground engineers of the flying clubs in India ; as a result of these tests a substantial improvement has been made and repair work is more dependable and flying safer. An interim report on tests of structural timber by Mr. L. N. Seaman was issued in June 1933 and gives safe working stresses for 129 Indian timbers. Mr. V. D. Limaye has prepared a third interim report recording the mechanical and physical properties of 140 Indian timbers.

In the Seasoning Section Dr. Kapur has evolved a process of kiln seasoning which is quicker, less costly and leads to less degrade than the process hitherto employed ; two firms are being assisted with the installation of kilns. The air seasoning of railway sleepers in the Punjab was investigated and a report issued. In the Wood Preservation Section

laboratory tests of the arsenic preservative " Falkamesam " have given satisfactory results, and it is hoped that the claims made for it will be substantiated. Mr. Kamesam is also devoting attention to the fixation of copper in wood.

The Wood Workshop Section tried a number of indigenous timbers for a variety of purposes, apart from supplying timber throughout the Institute. Birch (*Betula alnoides*) from Bengal was found to have good qualities, and plywood was made from several other timbers. The panelling of figured laurel (*Terminalia tomentosa*) in the board room of the Institute is an exceptionally fine piece of work.

In the Minor Forest Products Section the " F. R. I." portable charcoal kiln worked satisfactorily, and good charcoal briquettes were made with *Bauhinia retusa* gum. The Paper Pulp Section was able to establish that bamboos (*Dendrocalamus strictus*) that have flowered and died yield a higher percentage of cellulose and paper than green culms, though rather more drastic digestion is needed. Satisfactory packing and wrapping paper was made from bagasse (crushed sugar cane), and small scale tests indicate certain further bamboos as suitable for the manufacture of pulp and paper. Laboratory results suggest a possibility of making artificial silk from *Melocanna bambusoides*, and pulp from *Eucalyptus globulus* appears suitable for use in admixture with long fibred pulp. Advice was given on a number of pulp and paper problems by Mr. Bhargava who was in charge of this section of the Institute.

The Chemical Branch records the results of the study of certain drugs, oils and fats. Contrary to expectations it has been found possible to grow *Artemisia maritima* with a satisfactory santonin content at the Institute, and it has been proved that storage of the seed of *Strychnos nux-vomica* does not involve any loss of strychnine. The Indian species *Derris uliginosa* was under examination as a possible source of rotenone, and the seed of *Actinodaphne hookeri* has been found to be an excellent source of lauric acid. Dr. Sri Krishna records that chemical examination of seasoned teak wood yielded neither an essential oil nor a fatty oil ; its oily nature is ascribed to the soft resinous substance it contains.

Mr. A. D. Blascheck, Inspector General of Forests to the Government of India and President of the Forest Research Institute, records his appreciation of work done by his staff. In spite of drastic economy much valuable research was in progress at the Institute, and a number of investigations yielded important results which can be applied at once. The staff of the Institute was reduced from 35 to 29 officers and the expenditure by nearly 30 per cent as compared with the average of the three previous years. Detailed reports of work in the several branches, lists of publications, and statements of staff and expenditure are given in the chapters and appendices that follow.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

No publication dealing primarily with experimental results obtained at Dehra Dun was published during the year, though such results contributed to a varying extent to the two papers referred to under *Records* below. Several of the investigations, however, are completed or sufficiently advanced to permit of useful deductions being drawn, and pressure of other work is the reason for their not having been written up.

Routine scrutiny of the copies of experimental plot records received from the provinces has been continued and suggestions made as required. There are at present 469 experimental plot files distributed among the provinces as follows:—Punjab 20, United Provinces 62, Bengal 83, Assam 10, Bihar and Orissa 75, Central Provinces 45, Madras 82, and Burma 88. Some of the plots dealing with *sal* regeneration in all these provinces except the first were visited by the Silviculturist during the year.

(ii) Natural regeneration.

The annual testing of *Anogeissus latifolia* seed from marked trees was carried out (Expt. 44). The year was an unfavourable one. During the past 5 years the average germinative capacity per 10,000 seeds has been 10, 12, 43, 24 and 14 respectively, the average seed crop per tree having been 5, 21, 23, 4 and 1 lb.

Seed crops (Expt. 10) of individual marked trees illustrated the general poor yields of the year, none of the *Shorea robusta* or *Terminalia tomentosa* under observation yielding any seed, and the *Pinus longifolia* but very little.

(iii) Investigations on seeds.

(*a*) *Seed weighments and germination tests.*—During the year 145 weighments were made including 8 species for which no previous records were available.

Effect of size of seed on germination and growth of seedlings (Expt. 57) was investigated for *Terminalia tomentosa* and teak, the seed being graded into five sizes for *Terminalia* and three for teak. The results for *Terminalia* appear to indicate both in plant per cent and average height an optimum at a point short of the maximum size, seed over 1·8″ length in 1932 and over 1·6″ in 1931 showing a falling off. Another test will be made.

For teak, the bigger the seed the better the results as shewn in the following statement, but the differences are small owing to very late germination.

Diameter class inches.	·4 to ·45.	·45 to ·5.	·5 to ·6.
Plant per cent	39	37	49
Average height at the end of first season, inches.	3·4±0·29	4·2±0·43	4·4±0·47

(*b*) *Seed storage* (Expt. 12).—Five species were added to the list under investigation, *viz.*, (23) *Melia azedarach*, (24) *Bombax malabaricum*, (25) *Schleichera trijuga*, (26) *Garuga pinnata*, and (27) *Cinnamomum camphora*. The results to date are tabulated below:—

Species.	Initial germinative capacity per cent.	Germinative capacity after storage. Stored in sacks. Period of storage in years.					Stored in sealed tins. Period of storage in years.				
		1	2	3	4	5	1	2	3	4	5
Acacia catechu	(85·5)	..	..	..	..	..	85	73	53	1	0
	(46·0)	2	3	0	..	..	46	6	1	0	0
Albizzia lebbek	(28·5)	..	..	26	..	..	23	28	16	13	5
	(34·5)	34	26	..	35	..	25	27	4	5	..
Albizzia procera . . .	(79·5)	..	..	..	..	..	79	69	86	56	43
	50·5	28	45	10	11	..	31	34	22	23	..
Bauhinia variegata . . .	(100)	..	..	..	..	..	100	69	11	0	0
	96	3	0	0	..	..	73	56	0	0	..
Butea frondosa . . .	83	0	0	..	..	..	3	0	0	..	..
	(70)	..	..	..	..	..	70	87	0	..	..
Buxus sempervirens . . .	3·1	0	..	..	..	..	0	..	..	..	..
Cassia fistula	19	60	19	20	9	..	..	28	44	9	..
Cedrus deodara	71	0	..	..	..	..	0	..	..	..	..
Dalbergia sissoo . . .	(79)	..	..	..	..	..	79	63	67	43	2
	91	..	..	..	..	..	41	92	84	0	..
Dendrocalamus strictus . .	56·5	1	0	..	..	..	54	43	..	..	..
Holarrhena antidysenterica .	83·5	53	4	0	0	..	63	..	20	4	..
Lagerstroemia flos-reginae . .	(28·5)	..	..	..	..	..	28	30	0	0	..
Pinus longifolia . . .	79	86	71	6	0	..	95	90	83	65	..
	(93)	93	50	0	..	..	..	..	..	..	..
Pongamia glabra	(11)	..	..	..	..	..	11	0	2	0	0
Sapium sebiferum . . .	(33)	..	..	..	..	..	33	5	3	0	0
	11	..	..	..	..	..	11	0	0	..	..
Tectona grandis	30	32	3	..	..	..	47	27	..	..	..
Terminalia belerica . . .	54	28	0	0	..	..	45	18	3	0	..
Terminalia tomentosa . . .	30	9	29	0	0	..	26	38	25	6	..
Xylia dolabriformis . . .	(38)	..	..	..	..	..	38	32	1	1	2
Zizyphus jujuba . . .	(85)	..	..	..	..	..	85	96	80	24	28
	86	91	97	50	3	..	89	97	72	22	..

ROYAL ASIATIC SOCIETY OF THE BOMBAY BRANCH

(c) *Aids to germination* (Expt. 13).—Last year's experiment with *Terminalia chebula* was repeated using 300 fruits in each test with the following results.

Treatment.	Germination per cent.		Plant per cent.		Average height at the end of first season.
	1931	1932	1931	1932	1932 Ins.
A. Pulp not removed, no treatment.	33·2	24·3	31·6	15·6	5·9
B. Pulp not removed, 1 minute in boiling water.	..	14·6	..	8·3	5·4
C. Pulp removed, 3 days in cold water.	26·5	22·6	25·3	15·6	5·5
D. Pulp removed, 7 days in sun	21·6	15·6	21·1	9·3	5·4

It will be seen that the untreated control gave the best germination and plant per cent as was the case last year. A line sowing with the same lot of seed, unpulped, made at the break of the monsoon, gave very good results, better than any of these nursery bed tests.

(iv) Investigations on seedlings.

The morphological seedling studies as reproduced in Troup's *Silviculture of Indian Trees*, were completed for five species—*Afzelia bijuga*, *Dolichandrone falcata*, *Nyssa sessiliflora*, *Sterculia campanulata* and *S. urens*. Eight others were partly done, *viz.*, *Altingia excelsa*, *Buxus sempervirens*, *Diospyros ebenum*, *Litsaea polyantha*, *Machilus gamblei*, *Miliusa velutina*, *Sterculia foetida* and *Tecoma undulata*. Some difficulty is experienced in getting seed to Dehra Dun in viable condition, and the winter cold or summer drought frequently kills or cripples the seedlings before the last required stage of development is reached.

The experiment (Expt.59) begun in 1930 on the effect of burning back *sal* line sowings was continued as the subject was one calling for statistical study to decide between conflicting reports from general observation. The resultant figures are tabulated below. There were two parallel experiments starting in 1930 and 1931 with lines 3 and 5 years old, 1½—2½ feet high. The 1930 set has been burnt three times running and for the first 2 seasons shewed no significant differences between the unburnt control, the cut back and burnt set, and the set burnt standing; in the third season, however, (1932) the unburnt control shewed a significant

lead of 20% in height (on about 5 ft.) over the other two sets. The 1931 set also shewed no significant differences in the first season, but in the second season in which the plants reached a height of about 5 ft., the set burnt standing shewed a significant lead over the other two which were very similar. The experiment is being continued to see whether these differences are maintained or increased and the effect of the burning without cutting back on the soundness and shape of the stems will be examined. The casualties from the burning have been quite unimportant.

Statement showing the results of burning back 3 and 5 year old sal *seedlings with and without previous cutting back*

Treatments.	Initial data.		At the end of 1st growing season.			At the end of 2nd season.			At the end of 3rd season.		
	Average height.	Percentage of established plants.	Average height.	Survival per cent.	Percentage of established plants.	Average height.	Survival per cent.	Percentage of established plants.	Average height.	Survival per cent.	Percentage of established plants.
	Ins.		Ins.			Ins.			Ins.		
1930 (3 year old *sal*)—											
A. Control (unburnt) . .	18·2±0·38	0	26·5±0·78	96	0	42·5±1·61	96	42	*65·8±2·20*	96	74
B. Uncut but burnt . .	19·8±0·39	0	28·1±0·68	92	0	42·2±1·07	92	12	54·4±1·17	87	29
C. Cut and burnt . . .	17·9±0·39	0	27·6±0·86	90	0	40·4±1·24	90	15	54·1±1·26	90	30
1931 (5 year old *sal*)—											
A. Control (unburnt) . .	30·1±0·87	0	43·8±1·33	100	48	59·9±1·73	100	70	..	..	..
B. Uncut but burnt . .	28·5±0·65	0	44·1±1·27	99	40	*64·3±1·43*	97	48	..	..	..
C. Cut and burnt . . .	*31·7±1·01*	0	45·8±1·43	100	40	58·1±1·61	83	69	..	..	..

NOTE.—Italicised figures are significantly greater than others of the same set.

(v) Investigations on trees and crops.

(*a*) *Seasonal course of height growth* (Expt. 2).—This study has been in progress for important species for several years now, perhaps long enough for correlation with meteorological fluctuations. Some preliminary compilation work has been done, but detailed analysis remains pending.

(*b*) *Phenological data* (Expt. 1).—The same remarks apply as for the foregoing investigation.

(*c*) *Inheritance of individual characters* (Expts. 7 and 67).—Seed of solid bamboo was received from Angul division and stock raised for further study. Seedlings were raised from seed from trees suspected of being hybrids between *Terminalia tomentosa* and *T. arjuna*; they showed a certain amount of variation and are being kept under observation.

(*d*) *Inheritance of climatic race characters* (Expt. 6).—Work was continued with all-India teak seed origin investigation, stock being raised for all the 11 origins under trial. Very marked differences are apparent in germination, appearance and early development, and this co-operative study will undoubtedly lead to useful results.

(*e*) *Inheritance of physiological race characters* (Expt. 6).—Small plantations of *Butea* and *Schleichera* forms reported to behave differently under lac culture were completed and extended.

(*f*) *Soil Quality Class indicators* (Expt. 49).—The quadrats in plantations of different species were continued and some new ones added to follow succession in societies of the more conspicuous soil covers.

(*g*) *Congestion in bamboo clumps* (Expt. 8).—The required set of plantations of different origins was completed and many of the clumps are really big enough to permit of experiments on the possible causes inducing congestion. Field observations were also collected in the Hoshiarpur and Lansdowne bamboo forests.

(*h*) *Effect of autumn irrigation on leaf fall of teak* (Expt. 65).—The conclusion reached last year was confirmed, that under Dehra Dun climatic conditions, abundance of soil moisture makes no difference to the date of the drying up and falling of the leaves.

(vi) Artificial Regeneration.

Weather conditions affecting results were as follows. The 1931 monsoon rainfall was low but well distributed, and the 1931-32 cold weather was completely rainless and consequently nearly free from frost. The hot weather was fairly normal though very dry. The 1932 monsoon broke on July 5th and was very strong and exceptionally well distributed providing conditions too moist for species more adapted to drier climate

or soil, so that damping off was prevalent. The 1932-33 cold weather was also marked by good rainfall, with some frost.

(*a*) *Line sowings* (Expt. 14) were tried with *Chloroxylon swietenia*, *Soymida febrifuga*, *Lannea grandis*, *Mallotus philippinensis*, *Eugenia operculata* and *Terminalia chebula*, both in the open and in shaded lines. All made a satisfactory start but the *Soymida* largely damped off later particularly in the shaded lines. *Carallia integerrima* and *Celtis tetranda* sown in 1931 mostly died during the cold weather, *Pterospermum acerifolium* and *Terminalia chebula* continuing to develop.

(*b*) *Rains entire transplanting in the open* (Expt. 18).—The following species were tried in 1932, the survival percentage at the end of the year being given in brackets. *Chloroxylon swietenia* (84%), *Lannea grandis* (90%), *Carallia integerrima* (83%), *Eugenia operculata* (98%), *Schleichera trijuga* (5%), *Pterospermum acerifolium* (91%), *Stereospermum suaveolens* (86%), *Mallotus philippinensis* (78%), and *Erythrina suberosa* (73%). Until the plants have got over a dry season no practical conclusions can be drawn.

The following results were obtained at the end of the second growing season with species tried in 1931, the figures giving initial and final survival per cent. *Bauhinia retusa* (76-39%), *Celtis tetranda* (44-16%), *Pinus longifolia* with naked roots (26-2%), and *Pterospermum acerifolium* (85-19%). The heavy casualties during the hot weather are in part ascribable to the exceptionally dry conditions.

(*c*) *Rains entire transplanting in cleared lines* (Expt. 19).—The following species were put out in 1932, the survival per cent at the end of the year being given in brackets. *Chloroxylon swietenia* (*nil*), *Lannea grandis* (59%), *Carallia integerrima* (76%), *Eugenia operculata* (96%), *Schleichera trijuga* (35%), *Pterospermum acerifolium* (99%), *Stereospermum suaveolens* (38·6%), *Mallotus philippinensis* (37·5%), *Erythrina suberosa* (29%). For the species tried in 1931, the following figures shew the fall in survival per cent during the second growing season. *Pterospermum acerifolium* (94-70%), *Celtis tetranda* (92-82%) and *Schleichera trijuga* (86-56%).

(*d*) *Winter transplanting in the open* (Expt. 20).—In February 1931 four species were put out and the survivals in December 1931 and 1932 were as shewn :—*Hymenodictyon excelsum* (89-80%), *Broussonetia papyrifera* (80-76%), *Schleichera trijuga* (12-12%), and *Cedrela toona* (5-5%) bearing out general experience that the first hot weather is the critical time. The following species were added in December 1932 :—*Lannea grandis*, *Chloroxylon swietenia*, *Soymida febrifuga*, *Mallotus philippinensis*, *Litsaea polyantha* and *Eugenia jambolana*.

(*e*) *Winter stump planting in the open* (Expt. 23).—Only *Erythrina suberosa* was put out in February 1931 ; survivals fell from 73 to 56 per cent during the second year but the growth was exceptionally vigorous,

In February 1932, *Butea frondosa* and *Albizzia lebbek* stumps were planted, of which the latter failed largely but the *Butea* gave 75% survival in December 1932. The following species were added during December 1932 :—*Acacia arabica*, *Anthocephalus cadamba*, *Garuga pinnata*, *Erythrina suberosa*, *Bauhinia retusa*, and *Bauhinia variegata*.

(*f*) *Rains stump planting in the open* (Expt. 21).—The following 12 species were put out in July 1932, the survival per cent at the end of the year being given in brackets. *Pterospermum acerifolium* (93%), *Schleichera trijuga* (92%), *Phoebe lanceolata* (99%), *Alcurites fordii* (100%), *Bauhinia variegata* (89·1%), *Adina cordifolia* (85·8%), *Albizzia lebbek* (100%), *Celtis tetranda* (94·3%), *Acacia arabica* (89%), *Bauhinia retusa* (54%), *Cedrela toona* (100%) and *Pistacia integerrima* (2%).

Of the species put out in July 1931, the percentages shewn below have survived to the end of the second growing season.

Species.	1931 RAINS STUMP PLANTING IN THE OPEN.			
	Planted on	Survival per cent on 1st January 1932.	Survival per cent on 1st January 1933.	Remarks.
Adina sessilifolia . .	22nd July 1931.	100	54	The *Santalum* and *Xylia* mostly died during the cold weather, whilst for the other species, casualties chiefly occurred in the hot weather.
Albizzia lebbek . . .	9th July 1931.	100	100	
Broussonetia papyrifera .	8th July 1931.	100	92	
Butea frondosa . . .	8th July 1931.	98	90	
Cedrela toona . . .	7th July 1931.	100	98	
Lannea grandis . . .	6th July 1931.	100	89	
Phoebe lanceolata . .	14th July 1931.	100	10	
Santalum album . .	6th July 1931.	80	0	
Terminalia myriocarpa .	7th July 1931.	37	13	
Xylia xylocarpa . . .	7th July 1931.	98	0	

In this connection, the early use of teak stumps in Travancore as recorded in *The Indian Forester* should be mentioned as well as the fact that further evidence has accumulated that under ordinary conditions there is no risk of the starting of rot by using the method.

(*g*) *Rains stump planting in cleared lines* (Expt. 22).—The following eight species were put out in July 1932 :—

(1) *Pterospermum acerifolium*, (2) *Schleichera trijuga*, (3) *Phœbe lanceolata*, (4) *Aleurites fordii*, (5) *Bauhinia variegata*, (6) *Albizzia lebbek*, (7) *Cedrela toona*, (8) *Acacia arabica*. Survivals in December 1932 were 90-100% for all.

Of the 1931 trials, the following survival percentages were recorded at the beginning and end of the second year : *Broussonetia papyrifera* (86-70%), *Albizzia lebbek* (98-94%), *Butea frondosa* (100-98%), *Cedrela toona* (100-96%), and *Xylia xylocarpa* (44-20%).

(*h*) *Effect of injury to stumps* (Expt. 30).—Two forms of injury were tried in 1931 with *Gmelina arborea* and teak stumps, stripping about one-third of the bark, and bruising with a hammer. The stumps were planted in pits with decayed leaf mould in order to approximate more to forest soil, probably more favourable for bacterial or fungal attack than the experimental garden soil. No significant differences were found between the several treatments.

(*i*) *Storage of stumps before planting* (Expt. 31).—250 teak stumps made on 5th July 1932 were planted in comparable lots of 50 stumps after an exposure of 0, 5, 9, 15 and 21 days to sun, rain and wind, in a heap on a cement floor ; it must be remembered that there was more or less rain on 15 of the 21 days. At the end of the growing season, the record was as follows, the 1931 experiment under less favourable conditions being also included :—

Length of storage.	Control.	3 days.	5 days.	9 days.	13 days.	15 days.	21 days.
1932 experiment. Average height in inches	0·6±0·33	0·9±0·33	..	6·3±0·26	..	5·9±0·26	5·8±0·20
Survival percentage .	94	92	..	94	..	100	76
1931 Experiment. Average height in inches	12·8±0·67	11·8±0·70	10·1 ±0·64	10·3±0·50	9·4 ±0·74	..	..
Survival percentage .	98	98	94	92	84	..	..

Storage, as found in the experiments of previous years, makes surprisingly little difference in survival or development.

(*j*) *Early planting of stumps without irrigation* (Expt. 61).—This was repeated with teak, twelve sets being put out fortnightly, beginning from the end of January to the break of rains, just as had been done in the two previous years.

The results provide a general confirmation of those already obtained, that a quarter or a third of the stumps put out in January or February

survive and shew a better average height than the normal monsoon planting. This year, however, the height superiority is slight, and hot weather planting, including the set put out 20 days before the monsoon broke, suffered very high mortality. It is intended to repeat this experiment a few times more for correlation of results with weather conditions, but it is now sufficiently established that for the Dun climate, spring planting is too much of a gamble to be a practical proposition.

(*k*) *Number of plants per patch.*—Work is being continued on this point which should yield statistical evidence on the subject of root competition, but there is nothing to report at present. Experiments with *Pinus longifolia* and *Tectona grandis* were started and have progressed satisfactorily so far.

(*l*) *Branch cuttings* (Expt. 32).—Propagation by branch cuttings of *Melia azedarach*, *Ficus glomerata*, and *Ficus roxburghii*, planted on 24th June 1932 after a shower of rain, proved a failure, though the monsoon set in well 10 days later.

(*m*) *Twig cuttings* (Expt. 76).—The results obtained in a propagation bench constructed and maintained on lines which have proved very successful in England, were disappointing. The twigs were kept green and healthy for several weeks and the cut ends usually callussed over, but with occasional exceptions, only feeble root development was obtained, or no roots at all (*Quercus*, *Machilus*).

(*n*) *Comparison of nursery stock and natural seedlings* (Expt. 56).—*Eugenia jambolana* jungle transplants were compared with two sets of nursery transplants, one being dug up from the nursery bed at the same time as the jungle ones and one immediately before planting. At the end of the first growing season no significant difference was found between the three sets, either in height growth or survival per cent. In all cases the survival per cent was more than 90. This confirmed the 1931 results with this species.

(*o*) *Comparison of nursery and forest stumps* (Expt. 46).—It was reported last year that with *Dalbergia sissoo*, forest stumps gave ⅔rds the survival of the nursery stock, but the same height growth in their first growing season: the same relationships have persisted to the end of the second season.

(*p*) *Comparison of sowings, transplants, and stumps* (Expt. 53).—Four species were used, indicating a higher survival and better height growth with teak stumps, higher survival (100%) but poorer height growth with *Bauhinia variegata* stumps, and lower survival but better height growth with *Acacia catechu*, illustrating well the great variation to be expected with different species. Marked superiority was found in height growth from stumps and transplants of *Gmelina* over direct sowings. These results refer only to the end of the first growing season,

an important point as is shewn by the 1931 experiment with *Terminalia tomentosa*. In this, survivals at the end of 1931 were 96%, 92% and 90% for transplants, stumps and sowings respectively, but at the end of 1932 had become 74, 26 and 66 respectively ; despite their casualties, however, the stumps retain their superiority of nearly 100% in average height. Experience with *Acacia catechu* is similar except that the sowings which were far behind in height after one season, have caught up to the transplants in the second, the stumps maintaining a 50% lead.

(*q*) *Soil working between lines* (Expt. 58).—Teak lines were found in a previous experiment to respond to an appreciable extent to soil working at the end of the rains. A repetition commenced at the end of 1931 has not given a similar result, the hoeing having been done on 5th December 1931 and 3rd October 1932, final measurements being taken in March 1933.

(*r*) *Araucaria cunninghamii plantation* (Expt. 68).—The small plantation started in June 1931 is doing well, having reached an average height of about 3 feet with only 2% casualties, but it was a good deal damaged by hail at the end of the year.

(vii) Nursery work.

In addition to raising stock of various species for use in the experimental garden and demonstration area, a few experiments on nursery practice were also carried out.

(*a*) *Manuring of nursery beds* (Expt. 16).—The relative value of farmyard, artificial farmyard and green manures were tested with teak (Travancore seed). The results of experiments made during the last six years were summarised and published in the May 1933 issue of *The Indian Forester*, with special regard to the utilisation of vegetable waste in the form of '*artificial farmyard manure*'. The method is decidedly a useful and economical one for permanent nurseries.

(*b*) *Nursery bed shades* (Expt. 14).—In 1931, 5 types of shades, *viz.*, batten 33% and 66% shade, bamboo chick, thatch and iron sheet, were tried using *sal* as it was known to do better with a certain amount of shade. Assessed on the best plant per running foot of drill lines the complete shades both gave better height and survival than the unshaded control and the partially shaded beds gave the same results as the total shaded. Both frost and insolation are in question. The batten and chick shades have the merit of convenience in handling but are more expensive than the thatch if this does not have to be purchased.

(*c*) *Weed control in nurseries* (Expt. 45).—Paper mulch was again compared with weeded beds for *Dalbergia latifolia*. The total dry

weight of weed growth was not very different but the prepared lines shewed a small but significant superiority in height. On the whole, the use of paper mulch has not proved worth while.

(viii) MISCELLANEOUS.

(*a*) *Effect of Tephrosia candida on soil moisture* (Expt. 64).—The 1930 experiment was repeated in 1931 with teak (Coorg) stump planted 6′×6′ in April 1929. *Tephrosia* was sown in April 1931 on worked lines 1½ feet broad between the teak lines. Soil samples were taken on 30th October and 17th November 1931, and again on 21st April, 18th and 29th June, 3rd and 18th October, and 2nd November 1932. The 1931 dry weather samples had shown more moisture for the *Tephrosia* area, but the 1932 samples showed less at all depths (6″-24″) and on all the above-mentioned dates. The weather conditions in the two years were not sufficiently different to account for this, and the cause may perhaps be found in the much more vigorous growth of *Tephrosia* and smallness of the teak plants in the 1932 experiment as compared with the 1931.

(*b*) *Changes of soil consequent on afforestation* (Expt. 48).—An initial set of soil samples from the four working circles, *viz.*, *chir*, *sal*, rosewood and teak were taken in 1927 before the plantations could have affected the soil. After 5 years, a second set was taken and analysed by the Biochemist.

The figures appear to shew that the top layers (up to 18″ depth) have become more porous after the afforestation. Nitrates were found to be in greater concentration in the top layers but the organic matter and the moisture fell throughout. Further quinquennial analyses are needed before any conclusions can be drawn.

(*c*) *Cover crops*.—Frost has virtually killed out the *Tephrosia tinctoria* and *Indigofera endecaphylla* experiments which were promising enough. Whereas a dense cover of *Tephrosia candida* was found definitely to raise the mortality of small teak from frost, with clear indications that the reason is lowering of soil temperatures by shading from winter sunshine, a light cover of *Indigofera tinctoria* appears to have protected *sal* sowings of the year.

(*d*) *Effect of grass in irrigated plantations*.—An investigation of the soil moisture with four types of cover, *viz.*, grass only, trees only, grass under trees, and no cover, was laid out in Chhanga Manga plantation of the Punjab in collaboration with the Provincial Silviculturist. The moisture content (down to 30″ depth) was determined at Dehra Dun. Two years' work has shown that the grass plots had a better moisture per cent practically at all depths and at all times of the year. The others in order of superiority were the grass-under-trees, trees only and

no cover. From this it is evident that removal of grass, however desirable on other grounds, does not improve the water economy.

(*e*) *Methods of working bamboos for maximum sustained yield in quantity and value.*—Experimental plots were laid out in Punjab (Hoshiarpur Division) and in the United Provinces (Lansdowne Division) after discussion with the local authorities. In Lansdowne Division, insect attack on the bamboos and overhead cover are important problems and the effect of burning had also to be taken into account. This work involved selecting, cleaning and measuring a total of 2,227 clumps.

(ix) Reclamation and afforestation.

It was hoped that the stocking of the 200 acres of demonstration plantations had been completed in 1931, but frost and drought killed most of the sowings of 1931 and they had to be done again in 1932.

(*a*) *Sal working circle.*—A total area of 4 acres was sown with Hoshiarpur, Gorakhpur small-seeded, Kheri, Haldwani and local origins.

(*b*) *Pinus longifolia.*—7½ acres were sown with Nainital, Hazara, Lansdowne, Chakrata and local origins.

(*c*) *Rosewood working circle.*—The one remaining compartment was planted up with stumps and 2,750 casualties replaced elsewhere.

(*d*) *Teak working circle.*—2,300 casualties were replaced in compartments of Burma origin by stump planting.

II.—STATISTICAL WORK.

(i) Yield Tables.

The chief work of the year has been the compilation of multiple yield tables for *Cedrus deodara*, giving crop values for different grades of thinnings. These are the first tables of their kind in India, and represent a commencement on a line of work bound to become progressively more important. A publication on the subject is now in the Press.

A yield table for *Quercus incana* has been taken in hand. This species does not produce definite annual rings in its timber, and the tables are based in the first place on diameter and top height, instead of age and site quality which is the usual method. A special study has been made of methods of indirect determination of age and the results used to transfer the data to an age basis. These computations are nearing completion.

Compilation of stem distribution data for *sal* was also started as the need for data in this field is being keenly felt in connection with yield regulation in working plans.

Crown diameter data for deodar were collected in the sample plots of the Chakrata Division, United Provinces, by a field party under the Experimental Assistant to supplement a set collected in Kulu by the Punjab Silviculturist. This was done on the lines of recent work in Europe, in connection with the multiple tables, to obtain growth statistics for trees developing under optimum conditions of crown and growing space.

In connection with the measurement of standing trees, a field test was made with the sectional ladder constructed in the Institute. The results were decidedly encouraging and it is hoped to improve the ladder on the basis of experience gained, and to make further tests under typical conditions in hills and plains. Trials have already been made with instrumental and photographic methods.

The records of 298 sample plots were received for computation. Of these, 100 were for new plots, 194 for old plots remeasured, and 4 were for temporary plots.

The distribution of these plot measurements by provinces is as follows :—

Provinces.	No. of new permanent sample plots.	No. of old permanent sample plots re-measured.	No. of temporary plots.
Bengal	25	31	1
Burma	8	77	..
Central Provinces	..	11	..
Punjab	21	44	..
United Provinces	1	41	..
Jammu and Kashmir	45	..	3
TOTAL	100	194	4
GRAND TOTAL	298	..	..

The following statement shows the present distribution of the permanent and temporary plots by species and provinces :—

Statement showing by species the distribution of sample plots, permanent and temporary, in different provinces of India including Burma.

Species.	Number of permanent sample plots in each province.												Number of temporary sample plots in each province.								Grand Total.
	Andamans.	Assam.	Bengal.	Bihar and Orissa.	Burma.	Central Provinces.	Madras.	N. W. F. Province.	Punjab.	United Provinces.	Jammu and Kashmir.	*Total.*	Bengal.	Central Provinces.	Madras.	N. W. F. Province.	Punjab.	United Provinces.	Jammu and Kashmir.	*Total.*	
Shorea robusta . .	..	..	53	91	..	39	10	..	..	132	..	325	..	5	12	..	..	36	..	53	378
Cedrus deodara . .	..	..	..	..	..	..	..	..	75	44	19	138	..	..	..	..	37	25	..	62	200
Pinus longifolia . .	..	..	..	..	..	2	..	1	38	52	1	94	..	..	..	4	8	56	2	70	164
Pinus excelsa . . .	..	..	..	..	..	..	..	9	21	14	39	83	..	..	..	5	35	6	1	47	130
Tectona grandis . .	3	1	11	13	226	38	46	..	..	5	..	343	..	12	..	..	..	1	..	13	356
Dalbergia sissoo . .	..	..	..	..	..	..	..	..	37	28	..	65	..	..	..	..	2	7	..	9	74
Other species . . .	6	16	111	27	81	14	15	..	14	93	..	377	20	26	11	..	5	9	..	71	448
Total .	9	17	175	131	307	93	71	10	185	368	59	1,425	20	43	23	9	87	140	3	325	1,750

The largest number of permanent sample plots for a single species is 343 for *Tectona grandis*, distributed over eight provinces though two-thirds are in Burma. *Shorea robusta* has 325 plots distributed over five provinces. About 30% of the total number of plots are for the coniferous species, about 40% for *sal* and teak, and the remaining 30% for the other species.

The following statement shows the progress made in laying out plots for the species listed by the Silvicultural Conference in 1929 as requiring yield tables. Progress is obviously slow, but it is to be remembered that for most of the species plots are only available in young plantations; actually only nine plots have been added during the year. As noted above, it has been possible to compile provisional tables for *Quercus incana*. Of the remaining species, *Acacia catechu* and *Terminalia tomentosa* are of widest interest.

Species.	Assam.	Bengal.	Bihar and Orissa.	Burma.	Central Provinces.	United Provinces.	Total.	Added since March 1929.
Acacia catechu	..	..	..	2	..	7	9	3
Acacia arabica	..	..	..	..	..	..	..	..
Alnus nepalensis	..	8	..	..	..	..	8	7
Casuarina equisetifolia	..	..	9	..	..	..	9	..
Cryptomeria japonica	..	12	..	..	..	..	12	11
Dalbergia latifolia	..	..	..	..	..	1	1	1
Eugenia jambolana	..	..	..	..	..	8	8	4
Gmelina arborea	2	11	2	8	..	2	25	6
Michelia champaca	..	4	..	..	..	..	4	1
Michelia excelsa	..	2	..	..	..	..	2	2
Quercus incana	..	..	..	..	..	34	34	1
Terminalia myriocarpa	1	8	..	..	..	..	9	5
Terminalia tomentosa	..	1	10	11	1	9	32	5
TOTAL	3	46	21	21	1	61	153	46

The total numbers of permanent sample plots on the records during the last 3 years are as follows :—

1930-31	1,246 plots.
1931-32	1,327 plots.
1932-33	1,425 plots.

Thus there has been a net increase of 98 plots during the year all laid out by provinces. Only 153 files were computed during the year as compared with the record number of 444 dealt with the previous year. This was due to the staff of this section being largely engaged on special computation work mainly in connection with the deodar yield table.

(ii) Volume tables.

Two statistical parties toured during the winter for about 8 week in the Haldwani Division, United Provinces, and collected the following data :—

Species.	Number of trees measured.	
	Standard volumes.	Commercial volumes.
Holoptelea integrifolia	231	228
Bombax malabaricum	87	212
Dalbergia sissoo	29	29

The work of the parties was inspected while in progress by the Statistical Assistant.

Volume tables for *Holoptelea integrifolia* (*kanju*) and *Trewia nudiflora* (*gutel*), in United Provinces, and for *Bombax malabaricum* (*semal*) in Central Provinces, were published.

III.—MISCELLANEOUS WORK.

The chief items of work undertaken during the year were :—

(*a*) Computation of commercial volumes for 2,874 teak trees (Allapilli Range, S. Raipur Division, Central Provinces), and compilation of a volume table from them.

(*b*) Computation of commercial volumes of 504 *sal* trees (Kolhan Division, Bihar and Orissa), and compilation of volume tables from them.

(*c*) Computation of stem analysis data for teak, 76 trees, Burma.

(i) Photographic Section.

The routine work dealt with compares with the previous years as follows :—

——	Negatives made.	Prints made.	Lantern slides made.
1930-31	1,471	2,680	128
1931-32	1,071	2,661	60
1932-33	677	2,276	44
Total at end of 1932-33 .	3,219	7,617	232

In the interests of retrenchment, the services of the head photographer had to be dispensed with from 13th August 1932, since when all the work has been done by the assistant photographer who fortunately has several years experience in the section.

Of the new negatives, 192 were taken by the Silviculturist on tour in seven provinces, 150 concern the Timber Testing Section, and 335 were new subjects taken at the Research Institute. 288 photographs have been received directly or indirectly from the provinces forming a very useful addition to our collection, but one which might well be far larger. 48 photographs were utilised for illustrating publications of various types.

The usual annual collection of selected silvicultural photos added during the year to the Central and Provincial collections was circulated to all provinces and extra prints prepared as indented. A considerable amount of work was undertaken for the Punjab Silviculturist to bring his recently organised print collection up to date.

A number of stereoscopic photographs have been taken during the year, and are considered decidedly helpful for certain subjects where depth of view is essential, notably sample plots, thinnings and some other experiments. Some photographic tests were also made in connection with the measurement of standing sample trees in sample plots.

The silvicultural specific collection now has 3,501 prints, and the general collection 2,662 prints—of course some photographs are duplicated. These collections made steady progress, but at a disappointingly slow rate, so that it is usually difficult to meet a request for a photograph suitable for reproduction, for any specified subject.

(ii) Records.

Referencing work has nearly kept up with new forest literature coming in during the year, and one or two of the items of arrears have been worked off. As noted last year, much of this work can only be done by title, even where close scrutiny seems called for, and there is an ever-accumulating pile of selected articles by forest research workers in various parts of the world, awaiting attention. Another urgent need is the examination, weeding and summarising of the existing files on general silviculture, with the ultimate view of preparing a compilation of existing Indian silvicultural knowledge to serve as a starting point for further work. The amount of material on the specific ledger files is now so great that a complete revision of Troup's *Silviculture of Indian Trees* (1921) is out of question, and the best line of work would appear to be a gradual revision of the most important species or groups of species, somewhat as is referred to above for *Shorea robusta*.

With the addition of 22 specific and 32 general ledger files, the number of current files now stands at 1,173 specific and 421 general.

There were 89 additions to the library which now contains 916 volumes, including 323 of bound periodicals. A list of important additions with brief notes on each was circulated to Provincial Research Officers as usual.

The available information on two important subjects *The Problem of the Pure Teak Plantation* and *The Importance of the Origin of Seed used in Forestry* was compiled, in the former instancemainly on the basis of reports contributed by the provinces concerned, and published as Forest Bulletin 78 and Ind. For. Rec. Vol. XVII, Pt. V, respectively. This procedure of publishing up-to-date surveys of existing knowledge on leading silvicultural problems appears to have been found helpful and it is hoped to continue it.

The results of an independent investigation were published as an Indian Forest Record (XVII—IV) entitled *The Sutlej Deodar ; its Ecology and Timber Production* by Dr. R. Maclagan Gorrie.

(iii) Working Plans.

Notes have been written on 17 draft working plans during the year, from 9 different provinces, and the suggestions made have very generally been adopted. This work takes up an appreciable proportion of the Silviculturist's time, but is well worth it.

(iv) Museum.

Work continues on the large scale models of silvicultural systems, that illustrating conversion to uniform with clear felling of irregular forest and *taungya* regeneration having been completed, and various improvements made in the older exhibits. The sixth model representing the strip system is now under construction. The preparation of these models were primarily undertaken to facilitate technical instruction of forestry students, but the museum has a wider appeal and there have been many visitors during the year.

(v) Staff and touring.

The Silviculturist made a tour in the Punjab in May-June 1932 with the Punjab Silviculturist to advise him with regard to research technique most suitable for the numerous new experimental plots laid out by him for study of regeneration problems in fir forest. The opportunity was also taken to inspect the areas selected as perpetual reserves of unworked forest types, and to initiate some crown measurement work required in connection with the new deodar yield tables. The Experimental Assistant toured in Jaunsar, United Provinces, to collect further data on this latter subject, and the Silviculturist joined him there for a few days to correlate the two sets of figures.

In January-February 1933, the Silviculturist made a long tour covering the *sal* forests of the United Provinces, Bengal, Assam, Bihar and Orissa, Madras and the Central Provinces, meeting many local officers in each province for a joint investigation into regeneration and management problems for this species. A draft report was prepared and circulated at the end of the year and the final revision will shortly be published.

The Experimental Assistant spent 3 weeks in Hoshiarpur Division, Punjab, initiating a series of experiments for an investigation on modern lines into problems of bamboo management. At the end of the year, he went to Lansdowne Division, United Provinces, to lay out a corresponding set of plots. The intention is to hand these plots back to the Provincial Silviculturists concerned for maintenance after a final inspection by the Central Silviculturist, as maintenance should be possible locally although the staff was not available for the decidedly laborious initial work.

The Statistical Assistant only made short tours to supervise the work of the field parties in various parts of the United Provinces. Mr. Mahendru's period of deputation after three periods of extension came to an end shortly after the close of the year under report, and he will be greatly missed. During the 4 years he has been in charge of the section, the standard has been considerably raised and there has been a steady output of original work. By dealing so efficiently with all mensuration and statistical work, both routine and special, he has very considerably relieved the Silviculturist, giving the much needed opportunity for developing other activities of the Branch.

The unpublished report on the tour made by the Silviculturist in 1931 of European Forest Research Institutes, was rewritten in the form of a series of articles each dealing with one aspect of silvicultural work, for publication in the *Indian Forester*, in which they appeared monthly from October 1932 onwards.

CHAPTER III.—BOTANY BRANCH.

Systematic Botany.—The systematic study of the Graminaceae of Duthie's Flora of the Upper Gangetic Plain was continued by Mr. R. N. Parker. In this connection a paper on the genus *Cymbopogon* in North-West India has appeared in *The Indian Forester* and a new species *C. osmastonii* was described from the Kheri district. A paper dealing with the systematy of *Vitis rugosa* and allied species also appeared in *The Indian Forester.*

Three other species of forest importance, two from Bengal and one from Burma were described. A new genus of the family Dipterocarpaceae, *Scaphula,* was described and its relationship with the allied genus *Anisoptera* was discussed.

A list of trees and shrubs from the Kashmir and Jammu Forest Circles, Jammu and Kashmir State, by W. J. Lambert, I.F.S., was published as a Forest Bulletin, Botany Series.

Work in connection with a simple illustrated handbook on 40 common Indian trees was undertaken during the year and early completion of this is expected.

Tours.—No tours were made by the Forest Botanist during the year.

Identification of specimens.—796 specimens were identified during the year including a collection of about three hundred specimens for the Bengal Forestry School at Kurseong. The remainder were specimens mostly sent in by Forest Officers from all over India, notably from Burma, Assam, the Punjab and the United Provinces.

Herbarium.—3,376 sheets were added to the herbarium during the year. About half of these are foreign specimens obtained by exchange chiefly from the Natural History Museum at Stockholm, Arnolds Arboretum and the National herbaria at Victoria, Melbourne, and Pretoria, South Africa.

Of the Indian specimens a thousand or more were supplied by the Forest Botanist, Burma, and the rest was made up of smaller collections sent in by forest officers from the various provinces and local collections. A collection of about a hundred specimens of South Indian plants was supplied by the Principal, Agricultural College, Coimbatore. The seed and fruit collections were re-arranged during the year.

Library.—40 books were added during the year in addition to 64 volumes of the usual periodicals.

Arboretum and Fruticetum.—In spite of some inevitable loss due to fungi, insects and unsuitable climatic conditions the arboretum continues to progress favourably. About 50 new plants representing 16 new species were planted out during the year.

The arboretum contains a representative collection of conifers which, though still young, are well-established and progressing favourably. In addition to *Ginkgo biloba, Cunninghamia sinensis, Tetraclinus articulata, Widringtonia cupressoides, Taxodium mucronatum, Callitris glauca* and *Cephalotaxis drupacea*,eleven species of *Juniperus*, ten of *Cupressus* and three of *Araucaria*, from various sources, have been grown.

With the exception of *Pinus longifolia* and *Pinus thunbergii*, some difficulty has been experienced in raising pines at Dehra Dun as they do not grow well beyond the seedling stage. The cause of their failure is under investigation and may possibly be due to some form of " damping off " by fungi or to the absence of necessary soil bacteria.

Of the three ornamental *Cassias, C. javanica, C. nodosa and C. grandis*, which appear to be only forms of one species, *C. javanica* from Burma has already been successfully grown and flowers freely. The other two, *C. nodosa* from Burma and *C. grandis* from Hawaii, are also being tried with some success though they suffer from frost in the Dun and require careful attention. In addition *Cassia multijuga* and *Cassia marginata* have been successfully raised and are now growing vigorously.

An F_2 generation of an apparent hybrid *Terminalia* (*T. arjuna* × *T. tomentosa*) is being raised with the idea of observing the segregation of such parental characters as may prove its hybrid origin.

In the experimental garden several species of exotic tropical grasses were tried with a view to finding out their suitability for use as forest fodder grasses. Of these the *teff* grass (*Eragrostis abyssinica*) was found unsuitable on account of its low yield and not proving perennial under local conditions, but the Rhodes grass (*Chloris gayana*) gave more promising results by proving perennial, reproducing itself freely by suckers and growing luxuriantly. Experiments with this and other grasses will be continued further.

Work in the fruticetum also progresses well and the plots are now becoming well-stocked and representative of their families especially the Leguminosae, Apocynaceae, Rubiaceae, Convolvulaceae, and Verbenaceae. About 200 plants representing nearly 50 new species were planted out.

In the creeper-house it has been possible to raise successfully such frost-tender plants as *Coccoloba uvifera* and *Codiæum variegatum* and also others of shady moist forests such as *Taraktogenos kurzii, Olea lurifolia, Hermannia denudata, Gomphostemma parviflorum* and some species of *Asparagus*, none of which could be successfully grown in the open in Dehra Dun.

Work in connection with the formation of the arboretum has led to inoculation experiments with root-nodule bacteria and as a result of

these the growth of *Casuarina, Mundulea suberosa, Erythrina fusca* and *caffra* and other plants have been considerably improved.

Supply of seeds.—Copies of a seed exchange list, in which seed of more than 400 species are offered, were distributed to correspondents and their requirements for experimental purposes supplied. In addition to this 17 indents for seed of forest trees aggregating some 3,000 lb. in weight were complied with. The chief requirements are from Java for seed of *Tectona grandis, Dalbergia sissoo* and *Dalbergia latifolia*; from South Africa for *Pinus longifolia* and *Cupressus torulosa* and from Ceylon for *Cupressus torulosa.*

Mycology Section.

Root Disease of Shisham (Dalbergia sissoo).—Twelve inoculations of *shisham* were made from fresh *Fusarium* cultures obtained locally from diseased trees with twelve controls. The result of these inoculations appears satisfactory. Cultural work in this connection is being carried on.

Gmelina die-back disease.—A preliminary investigation of the disease was carried out during the year. A large number of histological examinations were made of dead twigs, leaf buds and other growing points to locate, if possible, the seat of infection. The soil obtained from pits dug in the plantations has also been examined and possible predisposing ecological factors considered. Attempts have also been made to isolate the causative organism. Two types of fungus have been isolated from dead twigs.

Peridermium himalayense.—The second part of the investigation dealing with the results of inoculation experiments and control methods is complete and is being prepared for publication.

Peridermium indicum.—The morphology of the fungus on *Pinus excelsa* and *Ribes rubrum* has been worked out.

Damping off of forest seedlings in nurseries.—Observations were made on the germination and damping off of the following forest species sown in nursery beds under different soil conditions, *Soymida febrifuga, Terminalia tomentosa, Dalbergia sissoo, D. latifolia, Ailanthus excelsa, Gmelina arborea, Pinus caribaea, P. palustris.* Owing to the late sowing of the seed and the very heavy monsoon rains no definite data could be obtained.

Cultural study of wood-rotting fungi.—The stock cultures now include several important fungi some of which are pathogenic, such as *Fomes annosus* and several species of *Fusarium*, some wood-rotting, such as *Polystictus (Polyporus) sanguineus*, and others semi-parasitic such as *Ganoderma lucidum* and *Polyporus gilvus.* Some of these are maintained

for requirements in connection with mycological research while others, the wood-rotting ones, are maintained for the requirements of the Wood Preservation Section.

Routine work.—The collection and indentification of fungus specimens from Kulu, Kagan and Kumaon is being continued. It is proposed to send many of these to European specialists for identification. Some good specimens of the white-pine blister rust (*Cronartium ribicola*) and *Peridermium indicum* and of the *Cronartium* stage on *Ribes rubrum* have been added to the collections. Attempts are also being made to obtain, by exchange, a collection of *Polyporaceae* and *Thellophoraceae* from Bengal.

A large number of enquiries were received relating to the diseases of various forest trees and rot in timber.

CHAPTER IV.-- ENTOMOLOGY BRANCH.

Insects attacking Shorea robusta.

Damage by *Hoplocerambyx spinicornis* which occurred on a minor scale in the Central Provinces, in Dehra Dun, United Provinces, and in Vizagapatam, Madras, was easily controlled by standard measures.

Secondary Borers.—The dying-off of several thousand *sal* trees over about 3,000 acres in Haldwani, United Provinces, was investigated. The stagheaded and moribund symptoms associated with dry crown borers were followed by the establishment of *Gerontha captiosella*, *Diorthus simplex* and *Aeolesthes holosericea*, while *Hoplocerambyx* and pinhole borers were almost completely absent. *Gerontha captiosella*, a tineid moth, is usually an uncommon insect but on this occasion occurred in epidemic incidence. Its attack is associated with a carbonisation of the phellogen layer beneath the dead corky bark which has all the appearance of scorching due to departmental burning, but the possibility of its being a new disease is under investigation.

Control measures for the protection of undamaged timber were devised and adopted by the division. Nearly four thousand commercially useless *sal* were felled as trap-trees.

Similar dying-off on a smaller scale was reported from Dehra Dun division.

Insects attacking Tectona grandis.

Dihammus cervinus.—Food preference experiments were carried out with beetles bred from *Clerodendron infortunatum* in the laboratory. The ovipositing females showed no marked preference either for teak or for *Clerodendron*; the number of plants attacked and the number of eggs laid was approximately the same for each host plant. *Vitex negundo* and other controls were avoided.

The life-cycle was again determined as of one year's duration, — July 1931 to July 1932.

The sample plots in Haldwani Division, United Provinces, showed an increase in incidence from 1930 to 1931 and a fall to 1932. The increase was relatively greater, and the decrease relatively less in the unweeded areas than in the weeded areas. The average incidence however was low—the cankered and broken stems not exceeding six per cent.

Hyblaea puera.—Food preference experiments were undertaken with moths raised from wild larvae collected on teak. A choice of teak, *Premna latifolia*, *Vitex negundo* and *Callicarpa arborea* was provided

in the outdoor insectary. In one experiment the greatest number of eggs was laid on teak, and the next greatest on *Premna*. In a second experiment 8 days later abundant oviposition occurred on *Premna* and teak was scantily visited.

Kigelia pinnata coppice shoots are reported to be eaten by *Hyblaea puera*.

Amsacta lactinea (Arctiidae) has been bred on teak, *Clerodendron* and *Vitex*. The life-cycle is about two months.

Hapalia machaeralis.—An alternate foodplant is *Tectona hamiltonii*.

Parasites and Predators.—New records include a *Microbracon* parasitising the larva of *H. machaeralis*; a *Brachymeria* and a *Tetrastichus* parasitising the pupa of *H. machaeralis*. A species of *Monolexis* parasitic on the larva of the bamboo leaf roller, *Pyrausta coclesalis*, has also been bred from *H. machaeralis*.

Acherontia styx is parasitised by *Agiommatus acherontiae* and *Sturmia chatterjeei*.

Predators of teak defoliators have received further attention. *Chlaenius rayotus* and *Calleida rapax*, carabids, feed as larva and as beetle on *puera* and *machaeralis*; other carabids, *Parena nigrolineata* and a *Glycia* also feed on *machaeralis*; a mantid, *Hestiasula brunneriana* is an enemy of *puera*; *Xanthandrus indicus*, a syrphid, preys upon *puera* larvae. Among the spiders a species is under study; one individual devoured 70 larvae and moths of teak defoliators in six months.

These and previous records show that there are very diverse and effective natural limiting factors that can be put to good use in the biological control of teak defoliation.

The defoliation records under the Nilambur five year plan were completed and maps prepared. The ecological work proposed for the current year was postponed.

Spike Disease of Sandal.

Analyses of Collections.—The analysis of the fauna of sample plots was continued; records of seasonal incidence and distribution of seven families were wholly and of six families were partially completed.

In three sample plots situated in special observation areas in North Salem the numerical abundance of the sucking insects was found to be approximately the same in each plot. Jassids, which constitute about three-tenths of the hemipterous population, were equally abundant in all three plots; fulgorids were as abundant as jassids in one plot, but only three-fifths as abundant in the two other plots. The most abundant scar-making species were *Acropona walkeri* (equally numerous in the

spiked areas), *Petalocephala nigrilinea* and *Moonia albimaculata*, (not equally numerous), *Bythoscopus indicus* and *Ledra mutica* (relatively much less numerous). Together these five scar-making insects formed about a quarter of the hemipterous population in each plot and the incidence of spike was practically the same in each plot. These data tally with the evidence from other sources that the intensity of attack on sandal as measured by scars is roughly proportional to the disease incidence.

The study of the fauna of six host-sandal combinations in healthy and spiked areas has been concluded and one combination remains to be studied. Nearly 22,000 specimens are involved in these analyses. The relative incidence of species in the restricted host-sandal environment is found to differ considerably from the relative incidence in the region as a whole, indicating that the local insect population frequenting sandal is greatly influenced by the proximity of hosts, *e.g.*, the membracid, *Otinotus oneratus* is the commonest species on sandal in the general quantitative collections, but in the host-sandal combinations it is rare, being replaced by *Coccosterphus tuberculatus*. The most abundant insect on spiked sandal in the host-combinations is *Acropona walkeri* a species that is absent from localities where spike does not occur.

Taxonomy of Sandal Insects.—Nine reports on the identification of sandal insects and the description of new species have been prepared by specialists and sent to press, *viz.*—Carabidae by H. E. Andrewes; Neuroptera by N. Banks; Bostrychidae, Scolytidae and Platypodidae by C. F. C. Beeson; Exocentrus by W. S. Fisher; Membracidae by W. D. Funkhouser; Cicindelidae by W. Horn; Anthribidae by K. Jordan; Brenthidae by R. Kleine; Cercopidae by V. Lallemand. These cover 225 species which comprise only a small fraction of the insect fauna of sandal.

Bionomics of Sandal Insects.—Work in progress last year was completed. The alternate foodplants of some common sandal insects have been determined. Aphids, psyllids and thrips which appeared to be rare on sandal were obtained in abundance in the host-group collections.

Bionomic work at Bangalore by Messrs Dover and Appana was restricted to the life-histories of 12 species. Papers on the sandal fulgorids, *Sarima nigroclypeata* and *Eurybrachys tomentosa*, and the common jassid *Petalocephala nigrilinea* have been prepared for publication by Mr. N. C. Chatterjee.

Transmission Experiments.—Work at the sandal spike insectary in the Indian Institute of Science, Bangalore, concentrated attention on transmission experiments enbracing the largest number of apparently influencing factors. The essential principal was the introduction of "infective" insects on healthy plants for a definite period, after which

the plants were pruned to force out the symptoms of the disease. Experiments were conducted with individual species, groups of species, and a heterogeneous assemblage of species. In the first category 226 experiments, many of which were initiated by Mr. N. C. Chatterjee, were concluded by Messrs C. Dover and M. Appana during the year. Many more are in progress. Eighteen experiments with various groups were completed.

A capacious outdoor cage containing some 150 sandal plants and an average population of 20,000 insects served as an experiment of the third category and for the maintenance of a reserve supply of sandal insects.

Results show that (1) the leaf disease (chlorosis) caused by weevil attack did not persist in the new flush after pruning, and further experiments with weevils did not reproduce this symptom; (2) that spike-fed *Moonia, Petalocephala* and *Acropona* may produce a condition in previously healthy plants that bears a distinct resemblance to spike disease; and (3) that only a very limited number of species are able to survive on sandal sufficiently long for experimental purposes.

Experimental evidence as to the existence of an insect vector of spike disease is thus still negative, but theoretical considerations based on the natural infection of exposed pot plants and the non-infection of plants protected by insect proof cages admit the probability of infection by an agent moving above ground level. A summary of the results of preliminary transmission experiments has been prepared for publication.

Field collections were made in special areas, which confirmed the list of probable vectors furnished by the results of the quantitative surveys.

Bamboo Defoliators.—Five species of Pyralidae feeding on bamboo leaves were studied. *Pyrausta coclesalis* was found to hibernate as a larva until the end of May. Four generations are passed during the year with defoliation mainly during the monsoon period. The caterpillar moults six times.

Other species are *Massepha absolutalis*, and *Glyphodes indica*. The carabids *Calleida splendidula, C. rapax, C. pallipes* and *Chlaenius rayotus* are important predators of the caterpillars.

Bamboo Borers.—The project in which bamboos felled fortnightly were exposed to *Dinoderus* attack was completed and the incidence of damage analysed. Strength tests carried out by the Timber Testing Section showed that there is a distinct loss of strength on the average when the number of borer holes approaches 200 per six foot length but that there is no constant relation between the amount of borer attack and the strength of the specimen, *e.g.*, the three weakest pieces contained 5 bore holes and one with moderately high strength had 143

holes. Taking 10 holes as a defect sufficient to reject the bamboo for highest quality purposes it was found that 68 per cent of the material was sound at the end of $1\frac{1}{2}$ to $2\frac{1}{2}$ years.

The liability to damage varied throughout the year being least in bamboos felled from mid June to the end of July and highest in fellings from the end of December to May.

The safest period to fell bamboos is at the end of the hot weather and in the first month of the monsoon, and the next best period is from the end of the monsoon to the beginning of the cold weather (mid October to mid December for Dehra Dun).

No benefit is obtained by storing bamboos in the shade. Antiseptic treatment tests indicated that soaking in 2 per cent sodium fluoride in an open tank for at least 5 hours and slow cooling for a day gave practically complete protection. Creosote and fuel oil, " celcure " and salt solution were not beneficial. Smoking gives no protection.

The phases of the moon do not influence the liability to attack.

Estigmena chinensis and *Cyrtotrachelus longipes* are reported to be serious pests to growing bamboo.

Deodar Nursery Insects.—Insect conditions in deodar nurseries in Chakrata, United Provinces, were examined in June. In the seed beds fresh damage by cutworms was practically negligible—it is believed to occur much earlier in the year. In these seed beds a half to almost the whole of the mortality may be ascribed to causes other than insects. In the transplantation beds the one year old transplant is subject to attack by cockchafer grubs, which are responsible for as much as half the total mortality, the remainder being due to causes other than insects. In the second transplantation beds, with transplants 2 years old and over, mortality due to various factors including defective cultural operations was found to be high. Of the total casualties cockchafers were responsible for 10 to 30 per cent. Insects are apparently of less importance than are other factors causing the death of deodar plants between the ages of 6 and 30 months. The importance of cutworm damage in the spring will be studied next season.

Gamari Insects.—Calopepla leayana.—Further experiments with artificial hibernation shelters were conducted without discovering any practical procedure.

The parasite *Brachymeria* was bred through three generations and its life-cycle data rechecked—while the life-cycle is completed in a fortnight the adult fly lives from September to February, and for three months of this period without food.

Hollock and Pterocarpus marsupium Borers.—A large number of species of *Xyleborus* and other pinhole borers, with weevils and longi-

cerns and bostrychids and *Dihammus* and *Phassus* were bred from branch and stem wood of *Terminalia myriocarpa* dying in plantations in Assam. The diversity and irregular occurrence of the fauna indicated secondary attack on weakly resistant trees. The primary cause of the dying off was attributed to excessive density.

A mixed borer fauna was reared from dying *Pterocarpus marsupium* in plantations in Coorg.

Shisham Insects.—The life-history of the leaf minor *Leucoptera sphenograpta* was studied and hibernation as moth was determined. Oviposition from overwintered moths commenced in March.

Borers of Timbers.—General collection and rearing continued on standard lines. Special attention was given to the distribution and food plants of indigenous lyctids in connection with which timber yards in Calcutta and Bombay were visited. Results were summarised and published. Material used as dunnage by shipping leaving Indian ports for Europe was examined and its borer fauna reared.

The borers of *semul* (*Bombax malabaricum*) were specially studied and planks were subjected to bostrychid attack after treatment with antiseptics.

Termites.—Treated test pieces were distributed to various parts of India for exposure to attack by termites. During the period of 6 to 12 months all the antiseptics under test completely protected the wood.

General Insectary Work.

During the year 97 consignments of attacked material and insect specimens were received from various forest divisions of India for identification, etc. In the Insectary experiments in 389 cages were discontinued and 295 are still in progress. The total number of insects bred out was 35,875 and of these about 10,860 were set and labelled.

The local gall-making Psyllidae were studied :—*Pauropsylla depressa* (leaf galls on *Ficus glomerata*), *P. beesoni* (leaf galls on *Litsaea polyantha*), *Phacopteron lentiginosum* (leaf galls on *Garuga pinnata*), *Euphalerus vittatus* (on *Cassia fistula*), *Diaphorina citri* (on citrus), *Trioza jambolanae* (leaf galls on *Eugenia jambolana*), *T. fletcheri* and *Phylloplecta hirsuta* (leaf galls on *Terminalia tomentosa*) *P. malloticola* (leaf galls on *Mallotus philippinensis*).

Systematic Entomology.

The greater part of the time of the staff of this section was occupied in arranging and identifying the very large collections made during the sandal spike investigations, as in the previous year. Most of this work has been completed and several reports from specialists are ready for the press.

The number of insect species in the collection has been increased by 300. The collection of immature stages has been considerably augmented, particularly in beetle larvae. Four papers by the Systematic Entomologist on beetle larvae of economic importance were prepared for publication. Numerous papers by specialists on material from this Institute other than that connected with the sandal investigations have appeared in various scientific journals. Important advances in the taxonomy of Indian termites have been made by Dr. T. E. Snyder of the U. S. Bureau of Entomology ; a paper by Dr. Snyder on new Indian species will appear shortly.

Tours.—By Mr. J. C. M. Gardner to Bangalore (Spike Conference) and North Salem, Madras in April. By Dr. C. F. C. Beeson to Ranchi (Lac Cess Committee) in November and March ; to Haldwani, United Provinces in February ; to Calcutta in November ; to Bombay in March. By Mr. N. C. Chatterjee in North Salem, Madras in April-May. By Mr. C. Dover to Bangalore, Coimbatore, North Salem and Fraserpet, Coorg. By Mr. B. M. Bhatia to Chakrata, United Provinces in June ; to Haldwani, United Provinces in February ; to Bombay in March. By Mr. S. N. Chatterjee to Haldwani, United Provinces in April and February.

Lectures.—The course in Forest Zoology for the Indian Forest Service Class was conducted by Mr. N. C. Chatterjee—thirty lectures and thirty hours of demonstrations.

Mr. C. Dover delivered a public lecture on the entomology of spike at Bangalore and attended a symposium on spike disease at Coimbatore.

Museums.—About 160 specimens of damage to timbers by borers were added in the main hall, and a gallery opened for the display of damage by defoliators.

Charts and specimens were added in the museum of forest zoology.

Library.—136 books besides periodicals were added to the Zoological Library during the year.

Publications.—A list of all publications and articles in scientific journals is given in Appendix I.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

1. *Research.*

(*a*) Work in connection with the preparation of a hand lens key for the identification of important commercial timbers of the Punjab is almost complete. All photomicrographs (X 10) are ready, and the Bulletin will be sent to the press soon.

(*b*) 'Growth studies in some north Indian forest trees' were continued. 80 micro-blocks were taken from 7 different trees. Numerous sections have been cut, and the anatomical structure and micro-chemical reactions noted. The investigation will be continued with a view to establishing the results so far obtained, in the light of recent research done in European countries.

(*c*) Research on the anatomical study of woods of the Indian Dipterocarps was continued. Over 70 authentic specimens have been microscopically studied. More specimens will be taken up for study during next year.

(*d*) Experiments in connection with the improved method of softening micro-blocks in hydrofluoric acid have been continued with success.

(*e*) The anatomical study of some Indian woods in connection with their liability to attack by *Lyctus africanus* was completed. The results of this investigation have been published in *The Indian Forester.*

(*f*) The study of the wood of three varieties of *Terminalia tomentosa* has been continued during the year. Both Burma and Madras are interested in this enquiry.

2. *Identification of wood.*

Many wood samples were received for identification from various branches and sections of the Institute. Enquiries were also received from outside sources such as :—

(*a*) Chief Engineer, Madras and Southern Mahratta Railway.

(*b*) Messrs. H. Dear & Co., Ltd., Calcutta.

(*c*) Works Manager, Moghalpura, North Western Railway.

(*d*) Superintendent, Gun Carriage Factory, Jubbulpore.

(*e*) Chief Engineer, South Indian Railway, Madras.

(*f*) Birla Jute Manufacturing Co., Ltd., Calcutta.

(*g*) The Commissioner for the Port of Calcutta.

(*h*) Director-General of Commercial Intelligence and Statistics, Calcutta.

(*i*) R. E. Mody & Co., Bombay.

(*j*) Messrs. Bird & Co., Calcutta.

(*k*) Chief Engineer, Eastern Bengal Railway, Calcutta.

During the year under review 400 specimens were identified.

3. *Examination for fungus.*

Various enquirers sent wood specimens, suspected of having been attacked by fungus. The number of specific enquiries replied to in this connection was 30.

4. *Special enquiries.*

Several special problems were taken up on behalf of the officers of the Institute and forest officers in the provinces. Technical information was also supplied to other enquirers from various parts of India.

5. *Accumulation of anatomical data.*

In course of routine work, over 120 data sheets were filled up and filed for future reference.

6. *Collection of authentic wood specimens.*

(*a*) In India :—For the authentic collection 310 wood specimens were received from different parts of India.

(*b*) From abroad :—During the year altogether 129 wood specimens were received from the Federated Malay States and Australia, to whom thanks are due for helping to make a complete collection of commercial timbers of the world.

7. *Distribution of wood specimens.*

In response to requests from abroad and from various parts of India over 800 samples of timber were sent out to interested enquirers.

8. *General.*

The usual course of wood technology was given to the Indian Forest Service students.

Over 150 photomicrographs were sent to various persons interested in wood identification. The curator of the Lord Reay Industrial Museum, Poona, was supplied with 50 photomicrographs of various timbers and bamboos for exhibition in the museum.

9. *Publications.*

See Appendix I.

Timber Testing Section.

1. *Staff.*

It was again necessary for the sake of economy in material and power to work the laboratory and computing office intermittently. This has, however, helped a great deal in clearing the arrears of computation work and bringing it in line with the laboratory work.

2. *Special investigations.*

(a) *Effect of borer holes on bamboos.*

The study started last year to investigate the effect of different methods of storage on the degrade and loss in strength of bamboos has been finished. Attack by boring insects was found to result in a considerable reduction of strength, but from the data so far available it was not possible to establish any definite relation between the number of borer holes present and the degrade, as the strength appeared to be adversely affected by other factors in addition to insect attack.

(b) *Method of testing shear.*

A new shearing tool in which friction was reduced by the use of roller bearings was designed and constructed, and a number of tests were made to examine the accuracy of results obtained with the standard shearing tool. This investigation is still in progress.

(c) *Holding power of patent nails.*

Tests were made on the holding power of the "Stronach" patent non-splitting nails. Ordinary pointed nails and the patent nails were driven to an equal depth in different species of wood and the force required to pull each nail out was noted. The tests were made by standard methods taking every precaution to assure similarity of conditions. From the tests so far made, it appears that there is no important difference between the patent nails and the ordinary pointed nails either in holding power or in their tendency to split the wood.

(d) *Penetration of moisture through wood coatings.*

A study of the resistance offered to the penetration of moisture by various types of wood coating was started, but results so far obtained are not very definite.

(e) *Suitability of "Fridera" composition for bridge girder packing.*

An investigation as to the suitability of "Fridera" composition for use as a packing between bridge sleepers and steel girders was started as the result of enquiry from the Railway Board and several tests were made on the brittleness, hardness and plasticity of "Fridera."

(f) *Testing of glue joints for Ground Engineer's Licence.*

An important addition to the former programme of work was the testing of glue joint specimens submitted by ground engineers of the flying clubs of India. This study was undertaken at the request of the Inspector of Civil Aircraft and complies with the specifications of the British Engineering Standards Association. It is most gratifying to note that the quality of the work submitted by the ground engineers has shown a very substantial improvement since the timber testing laboratory undertook to check the work. This has had the effect of making the repair work of aircraft more dependable and flying safer.

3. *Routine testing.*

The output of results from routine testing was very much affected by the reduction of staff. Work was continued under Project 1 (Standard Tests of Small Clear Specimens) and Project 2 (tests of timbers in Structural Sizes). Tests of glues, plywood and tea boxes were also continued in co-operation with the Veneer Section.

No. of species tested during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	1	8	2	
Project 2	2	2	..	
Project 0 under various sub-heads				48 species.
Charcoal briquette tests				4 consignments.
Tests of glue joints for aircraft				22 consignments.
"Fridera" composition tests				10 consignments.

No. of species computed during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	2	8	1	
Project 2	1	2	..	
Project 0 under various sub-heads				48 species.
Charcoal briquette tests				4 consignments.
Tests of glue joints for aircraft				24 consignments.
"Fridera" composition tests				10 consignments.

Over 10,000 mechanical tests and 11,000 physical determinations were made in the laboratory during the year. Besides finishing the

computations of tests made, many tables and graphs were prepared in the computing office for use in the preparation of interim reports on Projects 1 and 2. Graphs and tables were also prepared at the request of the Timber Advisory Officer with the Railway Board, for the determination of the annual cost of sleepers. Special shrinkage determinations were continued and over 26,000 observations were recorded and computed during the year. Graphs have also been prepared from these observations and the results are being analysed.

4. *Literary work and advice.*

Mr. L. N. Seaman, Officer in Charge of Timber Testing, prepared an interim report on Project 2 (The Testing of Structural Timbers) during the year. This report, which was issued in June 1933, will make available tables of safe working stresses for 129 species of Indian timbers. Articles were also written by Mr. Seaman for *The Indian Forester* and *Current Science.*

Mr. V. D. Limaye, Assistant, Timber Testing Section, prepared the third interim report on Project 1 (The Mechanical and Physical Properties of Timbers Grown in India). This report is now in the press. It will, when published, make available reliable strength data and comparative strength figures for 140 species of indigenous timbers from the different provinces of India.

124 technical letters and reports were issued by the Section during the year. Some of the subjects dealt with are shown in the following list :—

1. Wood for skating rink floors.
2. Moisture resistance of various coatings.
3. Wood for making shuttles.
4. Wood for tool handles.
5. Suitability of " Fridera " for use between bridge sleepers and steel girders.
6. Wood for manufacturing bobbins.
7. Wood for aeroplane construction.
8. Possible substitutes for *Lignum vitae* for bearing blocks.
9. Holding power of patent nails.
10. Wood for picker arms.
11. Wood for boat hook staves.
12. Insulating properties of wood.
13. Wood for transmission poles.
14. Strength of twisted *chir.*

15. Wood for throat blocks in tennis rackets.
16. Wood suitable for carriage and cart bodies.
17. Wood for felloes, spokes and naves.
18. Wood suitable for boat building.
19. Wood suitable for steam bending.
20. Annual cost of wooden and metal sleepers.
21. Substitute for ash in making tennis rackets.
22. Wood for dance floors.
23. Possible substitutes for imported sweet gum (*Liquidamber styraciflua*).
24. Effect of borer attack on bamboo stored under varying conditions.
25. Suitability of Kashmir walnut for glue joint tests for aircraft as compared with American walnut.

The above list exemplifies the diversity of subjects dealt with by the section and indicates the great interest that is taken by officials and the public on the work connected with the scientific study of Indian woods which is being conducted at the Forest Research Institute.

Wood Seasoning Section.

1. *New method of kiln drying.*

It is a matter of common experience that most of the Indian hardwoods when kiln-dried from the green condition give unsatisfactory results. During the early stages of drying, even when very high humidity is maintained in the kiln, the surface layers dry rapidly to somewhere near the fibre saturation point, and as the drying progresses, a "moisture pocket" is formed in the interior, which results in case-hardening of the timber and requires long and tedious steaming operations, both during and after the process of drying. The process thus becomes not only lengthy and costly, requiring skilful supervision all the time, but affects the quality of timber to a certain extent. This can be avoided in the case of some woods, if the timber before kiln drying is allowed to partially air-season to about 20 per cent to 30 per cent moisture content. This practice is largely followed in the southern hardwood region of the United States of America, and is recommended by the forest department in Australia. Considering the highly refractory nature of Indian timbers, this double process of air and kiln drying would be rather costly for this country, as it would mean provision of elaborate air-seasoning sheds and kilns, double handling of timber, etc., and in some of the dry regions in the interior of the country the results

might still be far from satisfactory, on account of excessive cracking and splitting of the timber during the dry summer months.

A new process of kiln drying has been evolved by Dr. S. N. Kapur, Officer in Charge of the Section, by which this liability to the formation of moisture pockets (with the resultant case-hardening of wood) is greatly reduced. Any kiln, which is fairly air-tight and is equipped in the interior with the usual heating coils and propeller fans, is good enough for the new process. Briefly stated, after the kiln is loaded with timber and doors tightly shut, the fans are put into operation, and steam is allowed into the heating coils till the air is heated to the required temperature, when the steam is shut off and the air circulation continued till there is no further increase in the humidity of the air inside. At this stage the dampers are opened to exhaust the used air and to admit a fresh charge of air, which is again heated and circulated as before.

If the kiln is of fairly air-tight and water-proof construction, the air inside the kiln, which gets fairly dry during the heating stage, absorbs moisture from the wood and soon gets saturated, as long as the wood is above the fibre saturation point. Below the fibre saturation point the final humidity attained by the circulating air depends on the moisture content of the wood at that particular stage of drying. At the end of each cycle, any moisture gradient developed in the wood is automatically eliminated, the surface layers remain practically saturated, and case-hardening is almost entirely avoided.

It is interesting to note some of the results that have been obtained :—

(i) *Terminalia tomentosa.*—It usually requires (for one inch thickness) about 25 days to kiln-dry this wood from the green condition, containing about 75 per cent to 80 per cent moisture, with very frequent steaming operations during the kiln run. With the new process the drying was completed in 14½ days, and the dried material was found to be in perfect condition. After further experimentation it is hoped to be able to reduce the drying period to about 10 or 12 days.

(ii) *Dipterocarpus macrocarpus.*—One inch boards were dried in 12 days from green to 10 per cent moisture content. This timber is very difficult to kiln-dry according to the usual methods on account of the presence of oleo-resins. The condition of the dried timber was excellent.

(iii) *Terminalia myriocarpa.*—One inch boards containing up to 120 per cent moisture were kiln-dried in less than 11 days. The final condition was extremely satisfactory.

Similar good results were obtained with *Anogeissus latifolia* $2\frac{1}{2}'' \times 2\frac{1}{2}''$ sticks, *Machilus macrantha* $\frac{5}{8}''$ thick planks, *Terminalia paniculata*

1″ planks, and *Stereospermum chelonoides* ¾″ thick planks.

The advantages of the new process are that :—

i. It is easy to operate,

ii. It requires much less steam,

iii. Is more economical and

iv. Produces dried timber of very good quality.

The investigations on this new process are still under progress and the results quoted above are by no means final.

2. *Effect of various preliminary treatments on the seasoning of wood.*

There are some timbers which, in spite of the best care under air or kiln seasoning, are prone to surface cracking, an example being *Anogeissus latifolia*. Experiments were undertaken to determine whether any preliminary treatment can help in overcoming this difficulty. The following treatments were carried out :—

(1) Soaking in water for various periods from 1½ to 4 months.

(2) Boiling in water for 4 and 12 hours respectively.

(3) Steaming under pressure for various periods.

(4) Application of a coat of animal glue in aqueous solution to all the surfaces of timber.

(5) Application of a 50 per cent aqueous solution of glycerine to all the surfaces of timber.

The timber (*Anogeissus latifolia*, 2½″ × 2½″), after the various preliminary treatments stated above, was kiln-dried in an internal fan kiln. It was found that in the untreated lots, the loss due to the increase of surface cracking during seasoning was anything from 21 per cent to 36 per cent of the total volume. The least degrade was in the case of timber coated with glycerine solution (3·1 per cent), the next being soaking in water for 1½ months (4·4 per cent). The material is under test for effects on the mechanical and strength properties, shrinkage, hygroscopicity, etc., and a report will be issued during the coming year.

A similar experiment on *Juglans regia* was carried out, and a number of other species treated more or less on the above plan are under air-seasoning. In some cases, the effect of inorganic hygroscopic salts, such as calcium chloride, is also being investigated. It is hoped that this investigation may lead to some cheap method of seasoning hardwood sleepers without excessive cracking and splitting.

3. *Air seasoning.*

The practice of stacking small quantities of timber left over from material from Project VII was continued. During the year 10 species

were added, and the data obtained have confirmed the results reported last year.

4. *Vacuum drying of timber.*

An experiment with *Anogeissus latifolia* indicated a certain amount of success. From an initial moisture content of about 42 per cent, the timber came down to 7 to 8 per cent in the case of sapwood pieces, and 20 to 22 per cent in the case of heartwood pieces in 166 working hours. The vacuum pump, however, worked for 28 hours only. The surface cracking was not excessive. The difficulty lies in creating sufficient circulation of air in the rarified atmosphere inside the cylinder, which is very necessary for the proper drying of wood. In this connection certain improvements are under consideration, which will be tried later on.

5. *Ozone drying of wood.*

A few sticks of *Dipterocarpus alatus* (*gu jan*) were dried under controlled conditions, with the regular addition of ozone. The experimental observations were not complete at the end of the year.

6. *Seasoning of softwood railway sleepers.*

A report on the air-seasoning experiments carried out in the Punjab at the end of 1931-32 was issued, and copies were circulated to the authorities concerned. It is proposed to carry out a further series of experiments on a larger scale during the winter of 1933-34 at the Forest Research Institute, where greater control can be applied than is possible in out of the way depots.

7. *Shrinkage tests.*

Shrinkage experiments on small clear specimens were continued, and five more species were taken up during the year. The scope of the experiments has been broadened so as to give information on the following points :—

(*a*) Total shrinkage from green to air-dried and oven-dried conditions.

(*b*) Rate of shrinkage.

(*c*) Equilibrium moisture content at various relative humidity conditions.

(*d*) Rate of swelling and total swelling at various humidities.

(*e*) Rate of absorption of moisture on transfer from a lower to a higher relative humidity.

(*f*) Effect of various treatments of wood, such as soaking in water, boiling, steaming, etc. on the shrinkage, swelling and hygroscopicity of the wood.

8. *Specific gravity.*

The modified method of determining specific gravity by the Archimedes principle reported last year proved quite useful, and the experiments were continued. Two more species were taken up during the year.

9. *Methods of determining moisture content.*

An investigation was carried out during the year into the accuracy and reliability of various methods of determining moisture content of wood, and it was found that the usual method of oven-drying at 100°C., and the method of distilling off water with some organic solvent like xylol or toluene gave practically identical results, except in the case of woods containing volatile oils. The difference was found to be considerable in the case of *Cedrus deodara* and the investigation in case of this timber was pursued in detail. A study of the results obtained with 12 different samples of *Cedrus deodara* gave a range of 1·64 per cent to 12·17 per cent for the difference in the moisture content values obtained by the two methods, the average figure being 7·10 per cent. This in fact represents the percentage of volatile oils (based on the oven-dry weight of the wood), which are evaporated off along with water during the oven-drying process. It is therefore evident that the oven-drying method is practically useless for the determination of moisture in *Cedrus deodara*, particularly where reliable and accurate results are desired.

10. *Lillooah kilns.*

The installation of seasoning kilns at the workshops of the East Indian Railway continued to run satisfactorily under the supervision of the officer in charge of the Seasoning Section. A visit was paid by him during August 1932. At the end of the year, on account of lack of demand of seasoned timber, the kilns were temporarily shut down, but it is hoped that they will be again put into operation at an early date.

11. *New commercial installations.*

It is satisfactory to report that during the year two business firms decided to erect seasoning kilns at the advice of, and according to the designs supplied by, this section. These kilns are in course of erection, one at Margherita in Assam and the other in Calcutta. Since the pro-

cess of kiln-drying has been greatly simplified, there is great scope of expansion in this direction.

12. *Enquiries.*

During the year, about 2 dozen enquiries were dealt with by the section on various subjects relating to air and kiln seasoning of timber. The erection of the two new kilns mentioned above is a direct result of these.

13. *Publications.*

The " Report on the Air-seasoning Experiments on Softwood Railway Sleepers in the Punjab", by Dr. S. N. Kapur was published in the Railway Board Quarterly Technical Bulletin, Vol. III, No. 29, April 1933.

14. *Tours.*

While on tour to Lillooah, in August 1932, a visit was paid to the Government Rifle Factory at Ishapore, in connection with their enquiry regarding honey-combing of walnut during kiln-drying.

Wood Preservation Section.

1. *Work under Project IV.*

Sleepers of the following species were treated with creosote and with mixtures of creosote and crude oil, during the year.

	Number treated.
Pterospermum acerifolium M. G.	161
Kayea assamica M. G.	137
Acroxarpus fraxinifolius M. G.	200

Only the *Parashorea stellata* sleepers from Burma now remain to be treated under Project IV. They were not ready for treatment by the end of the year.

2. *Toxicity tests with arsenical and other preservatives.*

Preliminary laboratory tests for determining the relative toxicity of a number of chemicals against the bamboo borer (*Dinoderus* sp.) were conducted. Arsenical compositions appeared to be the most toxic for a unit of money.

Field tests for determining the relative permanence and the critical toxic concentration for protecting wood from termites and fungi of the following wood preservative chemicals were inaugurated :—

1. Arsenic pentoxide.

2. Arsenic trioxide.
3. Powell solution.
4. Thanalith U.
5. Falkamesam.
6. Colloidal arsenic tri-sulphide.
7. Copper sulphate.
8. Zinc chloride.
9. Celcure.
10. Mercuric chloride.
11. Sodium dichromate.
12. Sodium fluoride.
13. Zinc meta-arsenite.
14. Coal tar creosote.
15. Fuel oil.
16. Coal tar creosote and fuel oil (1 : 1).
17. Coal tar creosote and fuel oil (1 : 2).
18. Coal tar creosote and fuel oil (1 : 3).
19. Coal tar creosote and fuel oil (1 : 4).
20. Creosote fraction (200°C. to 220°C.).
21. Creosote fraction (220°C. to 245°C.).
22. Creosote fraction (245°C. to 260°C.).
23. Creosote fraction (above 260°C.).
24. Barium hydroxide.

The results up to date indicate the efficacy of copper sulphate and mercuric chloride, besides that of the arsenical preservatives; the lighter creosote fractions do not appear to be, on exposure to the elements, effective against termites. These tests are, however, still in progress.

3. *Adsorption tests with arsenical preservatives—especially Falkamesam.*

Several experiments, conducted to determine the relative adsorption in wood of arsenic with three typical arsenical wood preservatives, showed that, under ordinary conditions of treatment, this phenomenon does not seriously interfere with their use in commercial plants. Under commercial conditions, adsorption has to be allowed for; and occasionally the concentration of the solution must be determined and brought up to the initial concentration.

4. *Experiments on fixing copper and arsenic compounds in wood.*

In view of the high efficacy of copper against white ants, experiments were made with success to fix copper as well as arsenic in wood. Experiments in this connection are being continued.

5. *Field experiments with Falkamesam.*

At the instance of the Railway Board, nine hundred *chir* (*Pinus longifolia*) B. G. sleepers were treated with Falkamesam and sent to the North Western Railway for field test. Three hundred of the sleepers were also given an anti-splitting treatment consisting of dipping in a 10 per cent solution of a bituminous composition in crude oil.

6. *Advice to the Governments of Madras and Mysore regarding the use of treated timber.*

At the request of the Governments of Madras and Mysore, the officer in charge visited Madras and Bangalore, to advise several heads of departments regarding the use of treated timber. At the request of the Director of Agriculture, Madras, experiments were made to investigate the treatability of *Eucalyptus globulus*, *Casuarina equisetifolia* and *Borassus flabelliformis* (palmyra). The results indicated that the first two species could be treated satisfactorily in the sapwood, so that they could be better utilised in the round than in sawn timber in which the heartwood is exposed; whereas palmyra can be preserved very satisfactorily throughout.

7. *Water-proofing and anti-splitting treatments for wood.*

During the year, several preliminary tests were made to investigate the efficacy of cheap bituminous compositions (suspended in crude oil) to prevent splitting by water-proofing wood. These experiments yielded results that may be expected to lead to a special treatment of railway sleepers and structural timbers.

8. *Graveyard tests.*

Wood specimens treated with the following preservatives were laid down in the antiseptic test yard for durability trials against fungi and termites:—

1. Falkamesam.
2. Arsenic pentoxide.
3. Arsenic trioxide.
4. Ceasrot.

5. Presotim.
6. Thanalith U.
7. Treated plywood (82 pieces from Germany).
8. Sundeala boards.
9. Treated insulation boards.

During the year, untreated sticks of the following three species were laid down for test against termites :—

1. *Ulmus wallichiana.*
2. *Morus serrata.*
3. *Mimusops elengi.*

All the specimens under test in the antiseptic test yard were inspected twice during the year, and in the case of proprietary preservatives, reports were sent out to those concerned.

Pieces of wood treated with the following wood preservatives, and also those that were, after treatment with the preservatives, shaken (in a machine) 20,000 times with water, were laid down about the middle of 1932 in white-ant infested ground at Dehra Dun, Madras, Bangalore, Pusa, and Calcutta. All the pieces appear to have remained sound and intact according to the reports received about them.

1. Falkamesam (0·5 per cent. $As_2 O_5$, $2H_2 O$).
2. Falkamesam (1·0 per cent. $As_2 O_5$, $2H_2 O$).
3. Falkamesam (1·5 per cent. $As_2 O_5$, $2H_2 O$).
4. Zinc meta-arsenite (0·5 per cent. $As_2 O_3$).
5. Zinc meta-arsenite (1·0 per cent. $As_2 O_3$).
6. Zink meta-arsenite (1·5 per cent. $As_2 O_3$).
7. Powell solution (0·5 per cent. $As_2 O_3$).
8. Powell solution (1·0 per cent. $As_2 O_3$).
9. Powell solution (1·5 per cent. $As_2 O_3$).
10. Coal tar creosote.
11. Coal tar creosote fraction (above 245°C).
12. Coal tar creosote fraction (below 245°C).
13. Coal tar creosote and fuel oil (1 : 1).
14. Coal tar creosote and fuel oil (2 : 3).
15. Coal tar creosote and fuel oil (3 : 7).
16. Fuel oil.
17. Wood tar creosote.
18. Wood tar creosote fraction (above 230°C).

19. Wood tar creosote fraction (below 230°C).
20. Wood tar creosote and fuel oil (1 : 1).
21. Wood tar creosote and fuel oil (2 : 3).
22. Wood tar creosote and fuel oil (3 : 7).

9. *Tests against marine organisms.*

Thanks to the courtesy of the Bombay and Madras harbour authorities, test pieces treated with creosote and Falkamesam were sent to the Chief Engineers of the two harbours concerned for exposure to attack by marine organisms.

11. *Publications.*

A Forest Bulletin entitled "Testing and Selection of Commercial Wood Preservatives" was sent to the press towards the end of the year.

Wood Working Section.

1. *Wood Workshops.*

In addition to supplying other Sections with converted material for research purposes, a large variety of work of maintenance was carried out *e.g.*, flooring, measuring sticks, handles, tables, platforms, switch boards, tea chests, boxes, guards, showcases, ladders, drawing boards, frames, glue joints, aircraft specimens, seats, callipers, brackets, stands, rod and brackets, kiln fitments, and almirahs.

The Timber Testing Section was supplied with 9,604 specimens and the Wood Technology Section received 643 hand specimens and 26 Gamble specimens.

Various enquiries in connection with woodworking and related subjects other than veneers, plywood and glues were received. Amongst these were the following :—

(*a*) The installation of a factory for the manufacture of hammer handles.

(*b*) Tree felling machinery.

(*c*) Machinery for brush making.

(*d*) Parquet flooring.

(*e*) Manufacture of splints by machinery.

A course of lectures was delivered to the I. F. S. students on sawmills, wood working and plywood.

2. *Sawmill.*

233 logs were converted as compared with 342 logs converted the previous year. These logs were dealt with on behalf of the Timber Testing, Seasoning and Wood Working Sections.

About 1,500 maunds of timber was prepared for the charcoal experiments of the Minor Forest Products Section, 70 sleepers were converted, 300 crossers made, 4,700 paving blocks prepared, 600 posts converted, and 300 pegs and mallets prepared.

3. *Veneer Sub-Section.*

Several sets of tests on both ordinary and corrugated plywood were carried out on behalf of Messrs Bird and Co., Calcutta. These tests were made with a view to ascertaining whether the introduction of corrugations increased the strength of plywood and if so whether corrugated plywood could be made up with thinner plies. Test results indicated that in the matter of strength there was nothing to choose between the two forms of plywood. In the case of the corrugated plywood, however, the crests of corrugations took more than a fair share of rough usage in the drum box test and were rapidly worn through, which indicates that the same would happen in practical work.

Tests on birch burrs from the Conservator of Forests, Kumaon Circle, were completed and also plywood tests on *Betula alnoides* from Bengal. The latter material behaved very well in the drum box and other tests and, in the matter of strength, should make a good substitute for imported plywood. In addition, *Betula alnoides* made up into excellent tools, boot trees etc., and should make an excellent substitute for foreign birch for most purposes to which this species is put.

Plywood and glue tests were continued on :—

Aimoora wallichii.	*Machilus macrantha.*
Betula alnoides.	*Swietenia mahagoni.*
Duabanga sonneratioides.	*Tectona grandis.*
Grevillea robusta.	*Vateria indica.*

Tests were carried out on caseins supplied by Messrs Sen Manufacturing Co., Calcutta, and " Glupol " supplied by Messrs Polson Manufacturing Co., Bombay.

The flush veneer panelling of figured laurel (*Terminalia tomentosa*) in the board room was completed and is now under observation. This panelling has been much admired by everyone who has seen it.

4. *Enquiries received.*

Many enquiries relating to veneers and plywood were received during the year. Amongst the most interesting are the following :—

(*a*) The establishment of factories for the manufacture of plywood in India and in Bombay Presidency.

(*b*) The disposal of casein in India.

(*c*) The suitability of Indian timbers for 3-ply wood for manufacture of tea chests in Ceylon.

(*d*) The most suitable glues for use in India.

(*e*) The establishment of a plywood factory in Bareilly.

(*f*) Plywood for racing boats in Burma.

Minor Forest Products Section.

1. *F. R. I. Portable Charcoal Kiln.*

It was mentioned in last year's report that some of the lower panels of the kiln had a tendency to buckle on account of the intense heat generated in the kiln. To remedy this minor defect, $1\frac{1}{2}''$ angle irons were fitted as stiffeners at the base of the bottom panels instead of the $1''$ angle irons originally fitted. This alteration appears to have had the desired effect as there has been no buckling in subsequent trials.

In order to test the life of the kiln, burnings were carried out in the Institute grounds with material consisting mostly of green mango (*Mangifera indica*) and some other species felled on the estate. The results up to the end of the year were very satisfactory and no defect was noticeable in the kiln after 40 charges had been burnt.

Scale drawings of the kiln have now been made with a view to getting quotations from reliable firms for its manufacture in India.

2. *Charcoal briquetting.*

Further experiments with the small power-driven ovoid briquetting press were made using *Bauhinia retusa* gum and various starchy binders. The best briquettes were obtained with 5 per cent of gum and 4 per cent of powdered rice (cheapest quality bazaar rice was used). The amount of water required seems to vary between 30 and 40 per cent depending on the density of the charcoal used.

Charcoal briquettes prepared with *Bauhinia retusa* gum and starchy binders were found to smoke slightly when first lighted. It was also found that most of the smoke was due to the starchy binders and very

little to the gum. A series of experiments was, therefore, undertaken increasing the amount of gum while reducing the amount of starchy binders used. From these experiments it has been found that satisfactory briquettes could be made using 6 per cent of *Bauhinia retusa* gum only. Such briquettes burn well with practically no smoke. The briquettes prepared using starchy binders only, without any gum, not only give off a lot of smoke but crumble to powder if poked while burning.

3. *Determination of the calorific values of some Indian woods.*

The results of this investigation were published as Forest Bulletin No. 79 during the year.

4. *Minor Forest Products Garden.*

The area at the south end of the garden which up to now had not been cleared, was taken in hand during the year under review, and the ground has been levelled and paths laid out. A number of new exhibits were added to the garden during the year. The *Artemisia maritima* plants grown from seed last year suffered heavy mortality during the monsoon at the close of which only one or two plants were left alive in each bed. These survivors are, however, growing vigorously now. The cause of death was probably the water logging of the soil during the rains, as the soil and the subsoil consist of stiff clay.

To investigate the best conditions for the growth of *Artemisia*, some more seeds were obtained this year and sown in different types of soil on slopes and on level ground. Germination was good in all beds except in those containing a certain amount of lime in the soil.

Paper Pulp Section.

1. *Experimental Factory.*

Owing to the need for economy, the steam boiler was shut down at four different times during the year for a total period of about 19 weeks necessitating suspension of work in the paper mill. The operation of the mill had also to be stopped for another 5 weeks for the re-erection of the pulp-hall walls which had cracked so badly during the rains as to render the building dangerous.

(*a*) *Rod Mill.*—The open end Marcy rod mill, equipped with stainless liners and rods, was erected in the mill and was operated for a short period towards the close of the year under report. It is expected that this mill will be found very serviceable for carrying out pulping experiments on grasses and other short-fibred materials.

(*b*) *Disintegration of bamboos.*—Experiments on the disintegration of bamboos were continued during the year under report. The results obtained were an improvement on those of last year, but the desired end has not yet been achieved. It is proposed to continue the experiments during the current year.

(*c*) *Tests on flowered Dendrocalamus strictus bamboos.*—At the request of H. E. H. The Nizam's Government, pulp and paper making tests were carried out on three kinds of *Dendrocalamus strictus* bamboos *viz.* (1) One year old green bamboos, (2) freshly flowered bamboos and (3) bamboos which had flowered and died about 4 years back but were free from borer and fungus attack. The main object of the tests was to find out if flowered bamboos could be economically converted into easy bleaching pulp and thus serve as a reserve supply for a mill, during the period a flowered bamboo area was regenerating and maturing for exploitation. The tests showed that the flowered bamboos were not only as good a paper making material as unflowered bamboos, but gave a higher percentage yield of cellulose and paper. The digestion treatment required for the flowered bamboos was, however, slightly more drastic than that required for unflowered bamboos, due, apparently, to the former containing a higher percentage of lignin.

(*d*) *Tests on bagasse (crushed sugar cane).*—A few trials were made on the production of wrapping papers from bagasse, using the rod mill for beating the pulp. The experiments showed that bagasse pulp, particularly in admixture with some long fibred pulp such as bamboo pulp, can yield fairly satisfactory packing and wrapping papers.

(*e*) *Manufacture of paper.*—About 2¼ tons of writing, printing and type papers, and boards were manufactured in the mill and supplied to the Forest Research Institute and College and to the Government of India Press for the printing of Forest Research Institute publications.

2. *Laboratory.*

(*a*) *Preparation of pulp for artificial silk.*—Experiments on the development of an economic and commercial process for the purification of *Melocanna bambusoides* pulp to render it suitable for the manufacture of artificial silk were continued throughout the year and are still in progress. The desired end has not yet been achieved though a suitable pulp has been prepared on a very small scale. The process adopted in this case was, however, of doubtful *commercial* value, and the investigation must be continued.

(*b*) *Pulping tests on bamboos from Bengal.*—Autoclave tests were carried out on the following 5 species of bamboos from Bengal :—

(1) *Dendrocalamus hamiltonii (kokwa),*

(2) *Dendrocalamus longispathus* (*orah*),

(3) *Teinostachyum dullooa* (*dolu*),

(4) *Oxytenanthera auriculata* (*kalisari*),

(5) *Bambusa tulda* (*mitenga*).

All five species were found suitable for the manufacture of pulp and paper, either singly or mixed together. Semi-commercial tests on the above species are included in the programme of work for the next triennium.

(*c*) *Analyses of bamboos and grasses.*—Chemical analyses, consisting of the determination of pentosans, lignin, cellulose, ash, etc., were carried out for the following :—

(1) *Ischoemum angustifolium* (*sabai* grass),

(2) *Saccharum spontaneum* (*kans* grass),

(3) *Ochlandra brandisii* (*eta* bamboo),

(4) *Melocanna bambusoides* (*muli* bamboo) and

(5) *Dendrocalamus strictus* (male bamboo), (from Hyderabad State).

(*d*) *Tests on Boswellia serrata* (*salai wood*) *and Eragrostis elegantula* (*bhulwa grass*).—Both materials yielded a very low percentage of pulp which could neither be bleached economically nor converted into satisfactory papers and were, therefore, considered unsuitable for pulp and paper making.

(*e*) *Tests on Eucalyptus globulus* (*Nilgiri blue-gum*).—Autoclave tests by the soda, sulphate, and sulphite processes were carried out on this material. The yield of pulp by all three processes was satisfactory and the pulp also bleached easily. The pulp, however, is short fibred and can be used only in paper manufacture as a filler or in admixture with a long fibred pulp such as rag or bamboo pulp. It is proposed to carry out semi-commercial tests on this material in the future. It will also be interesting to test the material for the manufacture of mechanical or groundwood-pulp.

(*f*) *Softening of water for steam boiler feed.*—Routine analytical work in connection with the softening of the main supply of water for boiler feed was carried out, as and when required, with complete satisfaction.

3. *Lectures.*

The usual course of lectures and practical demonstrations were given by the officer in charge to students of the senior I. F. S. class.

4. *Technical information and advice.*

(*a*) Advice on certain technical points concerning the manufacture of straw-boards was given to Messrs The Straw Board Manufacturing Co., Ltd., Saharanpur.

(*b*) Mr. K. Nizamuddin, Paper Expert to H. E. H. The Nizam's Government, worked in the section for nearly two months. He was engaged on the investigation on bamboos received from the state.

(*c*) Correspondence was also undertaken with private individuals, commercial firms and government forest and industries departments in connection with 25 enquiries referring to pulp and paper problems.

5. *Bamboo Pulp Projects.*

The Burma bamboo pulp schemes have not materialised as yet, due, it appears, to the general depression prevailing all over the world.

The Commerce and Industries Department of H. E. H. the Nizam's Government carried out a detailed survey of bamboo forest areas in the north eastern districts of the state. A project for the establishment of a paper mill was submitted to the Paper Pulp Expert at the Forest Research Institute for perusal and criticism. The scheme appears to be quite sound and feasible.

The Madras Forest Department have completed the survey of bamboo forests in the Madeswaranmalai Reserved Forests (North Coimbatore and Kollegal Division). It appears that Mettur on the Cauvery is a very favourable site for the establishment of a mill for the manufacture of paper from bamboos from this area.

Mechanical Sub-Section.

This auxiliary sub-section continued to function satisfactorily throughout the year, and all plant and machinery were kept in working order.

In the Seasoning Section, three new blower type kilns were erected in place of the old Sturtevant kilns. One internal fan (reversible circulation) kiln was erected in place of one of the old Tiemann kilns. One small kiln of the type of an internal fan circulation system was erected. Two small constant humidity chambers (fitted with fans for internal circulation) were also erected. Most of the equipment for these kilns was made in the workshops. In the Paper Pulp Section, a rod mill was erected during the year and a number of modifications were made to improve the bamboo disintegrator. A new glue spreading appliance was made for the veneer shop and a number of additions and alterations were made in the wood preservation plant for carrying out experiments under a new method of treatment.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A. Drugs :—

i. *Polygonatum multiflorum.*
ii. *Indian Ephedras.*
iii. *Dodonæa viscosa.*
iv. *Indian Artemisias.*
v. *Strychnos nux-vomica.*
vi. *Senecio* spp.
vii. *Derris* spp.

B. Oils and Fats :—

i. *Vateria indica.*
ii. *Actinodaphne hookeri.*
iii. *Tectona grandis.*
iv. *Aleurites montana* and *A. fordii.*

2. Study of forest soils.

3. Miscellaneous enquiries.

I. A.—Drugs.

(i) *Polygonatum multiflorum* All. syn. *Convallaria polygonatum* Linn.—(Solomon's seal) is a popular remedy, in Europe, for removing bruises and discolouration of skin resulting from blows. This drug has recently been sent from Kashmir as it was of interest to see if it contained the active constituents, the glucoside *convallarin* and *asparagin*, which are found in the European varieties. Asparagin to the extent of about 0·2 per cent has been detected in the sample analysed but not *convallarin.*

(ii) *Ephedras.*—It was reported last year that *E. sinica* had been grown at the Institute from seeds obtained from China and on analysis were found to contain 0·75 per cent of the total alkaloids. Further analyses have been made in the third year of its growth and the results (tabulated below) show 1·1 per cent of the total alkaloids. This com-

pares very favourably with the alkaloidal content in *E. sinica* grown in China—

Date of collection.	Moisture in the air-dried sample.	Total alkaloids.	Total alkaloids in the sample grown in China.
15th September 1931	8·5	0·75	1·12
17th November 1931.	8·5	0·49	Not recorded.
7th June 1932 . .	9·0	1·1	The highest content is reached in early October after which there is a rapid fall.

Ephedra gerardiana was grown in Lahore (Punjab) by Prof. S. R. Kashyap, Professor of Botany in the Punjab University, from seeds obtained from Bashahr hills. A sample of this, collected in October 1932, was analysed and found to contain only 0·04 per cent. of the total alkaloids. Such a low alkaloidal content is surprising. The analysis of the soil on which it had been grown indicated the presence of a very large percentage (8 per cent) of lime. Such a high percentage of lime is, of course, not normal in garden soils in Lahore but appears to be accidental in this particular case and may account for the poor quality of the drug. It is hoped that if *E. gerardiana* were grown on a normal soil it might show much higher alkaloidal content.

A new species of *Ephedra* has been collected from the Upper Indus Valley. In appearance it resembles *E. intermedia* except that the stems are thicker and longer. On analysis it was found to contain 0·77 per cent of total alkaloids, the whole of which was found to be pseudo-ephedrine.

(iii) *Dodonæa viscosa* Linn. is a gregarious shrub, growing plentifully in the drier regions of the North-West and Central India and is very commonly grown as a hedge plant since it is not browsed by cattle. The natural aversion of animals to this plant suggested in it the presence of some constituents distasteful to them and it was thought that the very same constituents might possess some medicinal properties. In books on Indian medicinal plants it is mentioned that the leaves of *D. viscosa* when applied over a wound will heal it without leaving a white scar. It is also said to possess febrifuge properties. Since no information was available about the chemistry of this plant, it was thought desirable to investigate it with a view to finding some constituents of economic value, medicinal or otherwise. Chemical examination appears to indicate that the medicinal properties might be due to an alkaloid (0·02 per cent) and to the small amount of a glucoside which

the leaves have been found to contain. Both the alkaloid and the glucoside have not yet been identified. The leaves also contain a fair amount (10-15 per cent) of a neutral and an acidic resin and some amorphous bodies. The leaves and the bark contain tannins but appear to be of no value as tanning materials. Results of the preliminary examination have been published in *The Indian Forester* 1933, p. 78.

(iv) *Indian Artemisias.*—During the past few years *Artemisias* have attracted considerable attention, particularly the Indian species which, it was thought, would serve as an additional source of supply of the valuable anthelmintic santonin, monopoly for the supply of which had, hitherto, been held by Russian Turkestan. In India many species of *Artemisia* are found but it is only the *A. maritima*, Linn. (*A. brevifolia*, Wall), which grows abundantly in Kashmir, Kumaon and the North-West Frontier Province, that has so far been found to yield any santonin, as is evident from the findings of Simonsen (*Jour. Ind. & Labour 1921*, 539) and of Greenish and Pearson (*Pharm. Journal 106*, 2). Their observations and results established definitely the fact that Indian *Artemisia* contains santonin even though the santonin content is not as high as in the Russian species. Recent work on Kashmir *Artemisias* has, on the other hand, shown that in many cases a yield of over two per cent of santonin can be obtained and these figures are quite as high as those obtained from the Russian species. The richest sample from the Kurram Valley (North-West Frontier Province) has given over 1·7 per cent of santonin, but the yield is not so uniformly high in all *Artemisias* found in the Kurram Valley. It is only in certain areas that *A. maritima* rich in santonin is found while in others a santonin-free variety grows, even though these areas are only a couple of miles apart. No botanical distinction has yet been made of these two varieties and, therefore, in the field it is not possible to distinguish the richer variety. This fact is not peculiar to the Indian *Artemisias* alone but finds a parallel in the " two English varieties of *A. maritima*, var. *anglica* with drooping flowering branches containing no santonin while var. *gallica* with erect branches does contain it." (Chemist and Druggist, 1929, p. 726.) Similarly, in Russian Turkestan there is another variety of *A. cina* which contains practically no santonin and is, therefore, used in adulterating the richer varieties.

Since no botanical differentiation has, hitherto, been made in these forms or varieties, it was thought that soil analyses might show certain characteristics upon which the differentiation might be based. This view was further strengthened since a comparison of the climatic and the topographical conditions in which *A. maritima* grows and flourishes did not reveal any correlation between their santonin content. It is well known that difference in habitat frequently alters the chemical

constituents of a plant but this does not appear to be strictly true in the case of *A. maritima*. For example, there appears to be nothing in common in the habitat of the variety growing in Scotland and those growing in the Kurram Valley and yet both of them yield fair quantities of santonin. The Indian variety of *A. maritima*, Linn. (*A. brevifolia*, Wall) is found in the Himalayas at 4,000—12,000 ft. as far east as Garhwal, but more or less confined to the inner dry valleys to which the monsoon does not penetrate. The Scottish variety on the other hand, "grows on the east coast of Scotland. The sea-shore, where the plant was found is apparently very different from the dry, rocky mountainous regions productive of the foreign variety, but it is essentially the same in favouring the development of strongly xerophytic plants, such as *Artemisia*. It is similar to that large belt of Russia where the plant is so prolific, in being very saline and indeed at high tide is completely covered with sea-water". (J. Coutts, *Pharm. Jour. and Pharmacist 1929*, p. 603.)

The general characteristics that appear to have an influence on the growth of *A. maritima* are, the character of the soil, whether clayey or sandy, the salt content and the temperature in winter. In the Kurram Valley it has been observed that *A. maritima* growing on the ridges of cultivated fields always gave a higher yield of santonin than plants growing on uncultivated land. This together with the above observations led to examination of the soils of the various *Artemisia*-growing areas. The results given in the following table show nothing decisive, but they appear to indicate in a general way that higher content of available potash and a higher proportion of silt and fine sand are met with in the soils of the area in the Kurram Valley where *A. maritima* rich in santonin grows.

Area.	Depth.	Fine stone and gravel.	Coarse sand.	Fine sand.	Silt.	Clay.	Hygroscopic moisture.	Organic matter.	Available potash K_2O.	Available phosphate P_2O_5.	REMARKS.
Mallikhel .	0"-6"	6·7	22·3	31·0	31·4	8·6	1·85	3·95	0·011	0·021	*Artemisia maritima* growing in this locality is santonin free.
	6"-18"	8·1	10·6	25·8	39·1	16·4	2·21	4·51	0·011	0·001	
Nastikot .	0"-6"	0·9	22·3	38·2	30·3	8·3	0·76	4·41	..	0·001	Poor quality. Average santonin content is about 0·5 per cent.
	6"-18"	0·8	19·4	33·8	33·9	12·1	0·95	3·97	..	0·001	
Burki (wild area) .	0"-6"	*Nil*	16·2	60·9	19·6	3·3	0·45	6·09	0·033	0·001	Good quality. *Artemisia maritima* grows in this locality. Average santonin content is over 1·2 per cent.
	6"-18"	*Nil*	6·9	35·5	46·7	10·9	1·07	6·92	0·045	0·001	
„ (ridges) .	0"-6"	*Nil*	10·1	45·3	37·2	7·3	0·85	7·19	0·045	0·02	Average santonin content is 1·5 per cent.
„ (cultivated areas)	0"-6"	*Nil*	1·0	19·4	66·3	13·3	1·38	9·25	0·045	0·04	Ditto.

The wide differences in the santonin content could not be explained on the inconclusive results obtained from the soil analyses and this, therefore, suggested a careful search for certain botanical characteristics. Mr. R. L. Badhwar, late of the Botanical Survey of India, carried out the botanical survey of the *Artemisias* of the Kurram Valley and he observed that in certain areas the young plants had red stems while others had the usual green, but in both of these the colour changed to brown on maturity when the distinction in colour was lost. On chemical examination it was found that the red stemmed form always gave a high yield of santonin while the green stemmed *Artemisias* were santonin-free. Hence the santonin-rich form of *A. maritima* has been designated as *A. maritima* forma *rubricaule*. The seasonal variation of santonin in the *A. maritima* forma *rubricaule* has already been reported last year.

It was reported last year that successful attempts had been made to grow *A. maritima* from seeds obtained from Kurram Valley. The seeds were sown in February 1931 and these germinated in about 4—6 weeks. In April some of the young plants were transplanted in beds where they kept in good condition till June when slight withering due to excessive heat was observed. The plants were still tender at this stage and, therefore, no attempt was made to collect a sample for analysis. Two months later, however, during the monsoon a sample was collected and was found to contain 0·85 per cent of santonin. During the rains the plants suffered from water-logging, but they survived with only a few casualties. These were left untouched during the following autumn and winter ; and early in spring of 1932 fresh leaves made their appearance. In April the growth was fairly vigorous and a sample was collected and analysed when 1·3 per cent. of santonin was found.

The form of *Artemisia* grown at Dehra Dun divided itself in two sub-forms designated in the table as the x-form and the y-form, the only distinction between the two being that the x-form produced the flowerheads early in June while the y-form showed no flower-buds till mid August. From the general nature of the plant it appears that the y-form is the original *A. maritima* forma *rubricaule* and the x-form is only the acclimatised form of y. In the x-form, therefore, the maturity is earlier and the santonin content highest during the period preceding the monsoon.

Date of collection.	Santonin in x-form.	Remarks.	Santonin in y-form.	Remarks.
	Per cent		Per cent.	
1st May 1932 . . .	1·35	No buds . .	..	
4th June 1932 . . .	1·35	Young buds . .	1·07	Luxuriant growth but no buds.
1st July 1932 . . .	1·48	Advanced stage of buds.	..	
		Rains commenced .	..	Monsoon started.
18th July 1932 . .	1·02	Ditto .	0·66	No buds.
13th August 1932 . .	0·72	Yellow buds still unopened.	0·38	Ditto.
1st September 1932 . .	0·43	Plants withering .	0·26	Young buds appearing but plants withering.

The soil on which the above sample of *A. maritima* had been grown gave the following characteristics :—

Depth.	Coarse sand.	Fine sand.	Silt.	Clay.	Hygroscopic moisture.	Organic matter.	Available potash (K_2O)	Available phosphate (P_2O_5)
0"-6"	17·4	38·2	31·4	13·0	1·06	4·76	0·024	0·04
6"-18"	18·6	34·2	29·8	17·4	1·51	4·83	0·028	0·051

These results have been published in the *Quarterly Journal of Pharmacy and Pharmacology*, Vol. VI, No. 1, 1933.

(v) *Strychnos nux-vomica.*—It was reported by one of the exporters of *Strychnos nux-vomica* that the seeds as now exported from India no longer contained the same percentage of strychnine as in previous years. This conclusion they had based on the complaints received from their various purchasers in different parts of the world, who in recent years had noticed a marked deterioration of the alkaloidal content of *S. nux-vomica.* Since the method of preparing the nuts for shipment and the outward appearance of the goods shipped had remained unaltered, the true explanation of the cause remained a puzzle.

In course of a search for the probable causes, it was discovered that at some places the seeds are washed in water before they are brought on the market and in an insufficiently dried condition are stored at seaports in damp places, sometimes for a fairly long period before actual shipment. This suggested that the cause of deterioration might possibly be due to biochemical changes during storage in a damp condition. It might also be due to the seasonal variation, since the collection of the seeds either from the trees or from the ground is dependent on the availability of local labour and on other conditions and factors. In order to confirm the above suggestions the following experiments were planned and conducted :—

(1) *Storage experiments.*

(*a*) In dry condition.

(*b*) In damp condition over water and exposed to the atmosphere.

(*c*) Over water but not exposed to the atmosphere.

(*d*) Storage in laboratory and exposed to the atmosphere.

(2) *Seasonal variation.*

The results obtained indicate that there is hardly any deterioration of the alkaloidal content under the conditions of the experiments given above. The seeds that had been stored over water, no doubt, lost their original brightness and got covered with a surface layer of mould but the alkaloidal content remained almost unaltered during the period of about fifteen months, as is evident both from the chemical and the mycological examination of the nuts. The seeds that were heavily coated with mould were selected for analysis and the results obtained are given below :—

—	Total alkaloids per cent.	Strychnine per cent.
Mouldy buttons (from West Coast collections) .	1·9	1·0
Average alkaloidal content for West Coast seeds .	2·0	1·0

It is recorded in the literature (*Chem. and Drug.*, 1928, *108*, 296) that nux-vomica seeds with the most silky appearance yield the largest amount of alkaloids and it is a fact that old crop seeds which have been subject to long storage gradually lose the original silky appearance. From this it would appear that the loss of the silky appearance is indicative of the loss in the alkaloidal content. The literature also records that strychnine is chiefly contained in the inner portion of the seed and brucine chiefly in the outer layers. These observations appeared interesting and, therefore, have now been reinvestigated but the results recorded in the present communication do not confirm the views cited above. The silky coating forms nearly 20 per cent. of the total seed weight and can easily be peeled off after the seeds have been boiled in water for a few hours. The following table shows the proportion of strychnine in the total alkaloids, both in the silky and in the horny portion of the seed.

—	Total alkaloids (per cent).	Strychnine (per cent).	Brucine : strychnine (ratio).	
Seed as a whole	2·55	1·23	52	48
Silky coat	1·83	1·04	43	57
Horny portion	2·73	1·28	53	47

The samples that have now been examined contained the usual amounts of the total alkaloids as well as strychnine and the effect of seasonal variation and of storage on the alkaloidal content is of no practical significance. The explanation for the lower alkaloidal content had, therefore, to be sought elsewhere. The most probable one appears to be the adulteration with other species of *Strychnos* whose seeds closely resemble those of *S. nux-vomica*, but which contain very little or no alkaloid. The seeds of the Burmese species of *S. nux-blanda*, for example, are similar to those of the Indian *S. nux-vomica* but contain no strychnine whatever and have no bitterness (Small, Pharm. J. 1913, 90, 510). For a long time the Burmese species were confused with *S. nux-vomica*, but it is only recently that it has been botanically characterised as distinct (Hill, *Kew Bulletin*, 1917, Nos. 4 and 5, 121). Similarly are the seeds of *S. potatorum*, Linn., growing in the Deccan Peninsula, devoid of the poisonous properties. *Pharmacographia indica* (Vol. II, 507) mentions the seeds as yielding a bitter extract which principally contains brucine and no trace of strychnine.

The seeds of other Indian species of *Strychnos*, namely *S. rheedei*, Clarke, *S. cinnamomifolia*, Thw. and *S. colubrina*, Linn., have varying strychnine contents and their presence in commercial samples may account for the lower alkaloidal content of the drug.

The experimental results are recorded below :—

Strychnos nux-vomica seeds obtained from Sriharikota Range, Nellore District, Madras Presidency (East Coast) contained 8 per cent moisture 2·75 per cent of total alkaloids and 1·2 per cent of strychnine.

Months.	Storage over sulphuric acid.		Storage over water.		Storage over water and exposed to atmosphere.		Storage in laboratory and exposed to atmosphere.	
	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
June	2·50	1·20	2·55	1·30	..	..	2·65	1·25
July	2·75	1·30	2·55	1·30	2·75	1·25	2·60	1·20
August	2·75	1·25	2·50	1·20	2·45	1·20	..	1·25
September	2·70	1·30	..	1·30	..	1·15	2·55	1·25
October	2·75	1·30	2·55	1·25	2·40	1·15	2·55	1·20
November	2·50	..	..	1·25	2·35	1·20	2·50	1·20

Strychnos nux-vomica seeds obtained from Beltangady Range, South Mangalore District, Madras Presidency (West Coast), contained 9 per cent moisture, 2·2 per cent total alkaloids and 1·1 per cent strychnine.

Months.	Storage over sulphuric acid.		Storage over Water.		Storage over water and exposed to atmosphere.		Storage in Laboratory and exposed to atmosphere.	
	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
June	2·20	1·10	2·05	1·05	..	..	2·00	1·00
July	2·00	1·00	2·15	1·00	..	..	1·95	1·05
August	2·20	1·10	2·05	1·00	2·10	1·05	1·90	1·05
September	1·95	0·95	..	0·95	1·90	1·15	..	0·95
October	1·95	1·05	1·90	1·00	1·75	1·15	1·90	1·00
November	1·90	0·95	1·95	1·00	1·50	..	..	..
December	1·95	1·10	1·95	0·95	..	..	1·95	0·95

Seasonal Variation (East Coast).

	Fruits from trees.		Fruits and seeds from ground.	
	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.
	Per cent.	Per cent.	Per cent.	Per cent.
December	2·75	1·15	..	1·25
January	2·65	1·15	2·75	1·25
February	2·65	1·05	2·60	1·25
March	2·45	1·00	2·65	1·20
April	2·45	1·15	2·45	1·25

Mycological examination of the buttons was conducted by Dr. K. D. Bagchee, Mycologist at the Forest Research Institute, whose report is as follows :—Twelve buttons were examined from each lot, selection being made from those which appeared dirty, dull or abnormal coloured and suspected of fungus infection. Mycological examination showed that the fungal attack was noticed only on the seeds that had been stored over water and exposed to the atmosphere, and in these cases too the fungal attack had only been on the outside silky coat and had not penetrated into the horny portion of the button. Even in those cases where the fungal attack had been most vigorous the alkaloidal content had not varied. (These results have been published in the *Quarterly Journal of Pharmacy and Pharmacology*, Vol. V, No. 4, 1932, pp. 633-638.)

It may be interesting to mention that *S. nux-vomica* forms one of the important minor forest products of India and large quantities of it are collected both for export and consumption in the country. One of the chemical manufacturers in India has recently extended their plant to extract 1,000 mds. of *S. nux-vomica* seeds per month.

(vi) *Senecio chrysanthemoides.*—A number of European and African species of *Senecio* are already known to possess alkaloidal bodies, many of which are toxic, particularly to cattle. The Indian species, on the other hand, have hitherto not attracted any attention, consequently very little is known about their chemical composition or physiological action. Preliminary examination of *S. chrysanthemoides* obtained from Kashmir showed the presence of alkaloids (about 0·10 per cent) and inulin. From the total two definite alkaloids have been isolated one m.p. 225-26°C and the other m.p. 120° (soluble in water, very soluble in chloroform and sparingly soluble in ether). While this work was in progress, Manske published a paper on " The alkaloids of *Senecio* spp.": (*Canadian Journal of Research* 1931, 5, 651) and reported the isolation of jacobine (m.p. 223-24°C) an alkaloid from *S. jacobea.* A sample of jacobine was obtained from Dr. Manske and it helped to establish the identity of one of the alkaloids (m.p. 225—26°C) from *S. chrysanthemoides* and this was found to be identical with jacobine. Attempts are being made to establish the identity of the second alkaloid (m.p. 120°C) work on which is still in progress.

(vii) *Derris* spp.—In a note by the Deputy Trade Commissioner for India in London (*The Indian Forester*, 1933, p. 462) it was pointed out that trade with European markets in *Derris* root could be established if suitable varieties of *Derris* containing reasonably high content of rotenone were available. The Indian species of *Derris* do not appear to have been fully investigated and only casual references have been made to *D. uliginosa* and *D. malaccensis.* These have been reported not to contain any rotenone which is the active principle of *Derris* roots and yet these enjoy a fair reputation in India as fish poisons. The present enquiry was, therefore, instituted at the suggestion of the Agricultural Expert with the Government of India and of the Inspector General of Forests. Of all the species of *Derris* known, *D. elliptica* is the one that has been found to contain the highest content of rotenone. This species,* however, does not appear to occur anywhere in India proper; *D. uliginosa* on the other hand, is indigenous in certain parts of the country but has not shown any rotenone content even though it enjoys a reputation as an insecticide. This leads one to believe that the insecticidal value of *D. uliginosa* might possibly be due to sub-

* Since this had been written information was received about the occurrence of *D. elliptica* in certain parts of Assam. A sample from Dibrugarh was found to contain about 1 per cent of rotenone.

stances other than rotenone. A sample of *D. uliginosa* obtained from the Sunderbans Division, Bengal, gave the following results:—

Constituents.	Roots.	Stems.	Remarks.
	Per cent.	Per cent.	
Moisture . . .	3·7	7·2	
Ash	3·4	4·4	The ash contained a very large proportion of sodium chloride.
Ether extract . .	1·9	1·07	In case of *D. elliptica* it is reported to be 7·22 per cent.
Chloroform extract .	..	0·15	
Alcohol extract . .	5·9	2·0	
Methoxyl content of the ether extract.	4·3	..	In case of *D. elliptica* it is reported to be 13·5—14·7 per cent.

The low percentage of the extractable matter with ether and its methoxyl content indicated a very low percentage of rotenone which in actual experiments it was never possible to isolate. The presence of toxicarol and digueline in the ether extract was also not detected. This work is still in progress and it is intended to examine the drug periodically to study the seasonal variation. Meanwhile powdered roots and stems and an alcoholic extract of the roots have been sent to the Forest Entomologist for biological assay.

1. B.—Oils and Fats.

(i) *Vateria indica.*—When the work on this fat was ready for publication, a paper on the same subject appeared in the *Journal of the Society of Chemical Industry* (1931, 50, 471[T]) wherein Miss Jones had shown the fatty acids to consist of palmitic, stearic, arachidic and oleic acids. Since these results were not quite in accordance with those obtained here, it was considered desirable to withhold the publication and to re-check the data. The results obtained now appear to indicate the presence of myristic, stearic, lignoceric, isomeric oleic and oleic acids in the total acids from the fat, and a careful search for palmitic and arachidic acid did not reveal their presence. The slight differences in the results that were reported last year and those obtained now was due to the difficulty of complete separation of the unsaturated solid acids from the liquid acids. This separation has now been effected more satisfactorily and the component fatty acids are found to be myristic acid 1·2 per cent, stearic acid 58·8 per cent. lignoceric acid 0·6 per cent, and oleic plus isomeric oleic acids 39·4 per cent.

(ii) *Actinodaphne hookeri.*—The physical and chemical constants for the fat from the seeds were reported last year. Further examination shows the fat to consist of the glycerides of lauric acid (96 per cent) and oleic acid (4 per cent). A single crystallisation from alcohol removed the small amount of the liquid oil and trilaurin of iodine value zero was obtained. The fat from these seeds, therefore, appears to be an excellent source of obtaining pure lauric acid.

Pericarp on the kernels also yielded an oil which on cooling and 'chilling' deposited some trilaurin. The residual oil gave the following constants for the mixed acids.

Mean molecular weight	265
Iodine value	54·8
Saturated acids	33·0 per cent.
Unsaturated acids	55·8 „
Resin acids	11·2 „

(iii) *Tectona grandis.*—It is commonly stated in works on Indian forestry that teak wood contains an oil which possesses antiseptic properties and is present in such abundance that it could be used as a substitute for linseed oil in paints and varnishes. Chemical examination, on the other hand, indicates that seasoned teak wood contains neither an essential oil nor a fatty oil. The seeds, however, yield an oil but appear to contain no such constituent that could render teak wood immune from white-ant attacks. The seeds yield no essential oil but only an insignificant amount of a white flocculent matter.

The seeds gave 0·6 per cent of the kernels. The kernels when extracted with petroleum ether yielded 40·9 per cent of a bright red oil of the following general characteristics :—

Specific gravity at 20°C.	0·9213
Refractive Index at 25°C.	1·4655
Iodine value	107·5
Saponification value	194·5
Hehner value	93·2
Acid value	31·7
Acetyl value	146·1
Unsaponifiable matter	1·25 per cent.

The mixed fatty acids have the following chemical constants :—

Mean molecular weight	278·0
Iodine value	109·0
Saturated acids	25 per cent.
Unsaturated acids	70 „ „
Resin acids	5 „ „

A preliminary study of the mixed acids indicate that the oil consists of the glycerides of palmitic, stearic, oleic and linoleic acids, and a small amount of resin acids.

(iv) *Aleurites montana* and *A. fordii.*—Several samples have been examined during the year with a view to determining the oil content of the seeds collected from plantations in different localities. The tree, which is of Chinese origin appears to grow very well in certain parts of India and the oil content compares favourably with that obtained from the Chinese seeds. The following table gives the comparative figures:—

—	*A. fordii* from Kurseong.	*A. fordii* from Dehra Dun (Bull. Imp. Inst. 273, 1932).	*A. fordii* from Southern Shan States Division.	*A. fordii* Chinese origin (Bull. Imp. Inst. 268, 1930).	*A. montana* from Kurseong Division.	*A. montana* of Chinese origin (Bull. Imp. Inst. 270, 1930).
Kernels	61·5	45·24	61·6	54	60	52·5
Moisture	19·6	5·0	4·2	4·5	16·1	5·9
Oil content on dry basis .	41·3	51·6	48·5	58·5	52·5	59·8

2. *Forest Soils.*

It was reported last year that data was being collected on the changes in the properties of soil as it passed from cultivated agricultural land to forest land. The agricultural land of 1927 is now covered over with a young forest which has been divided into four areas namely, the *chir* (*Pinus longifolia*), the *shisham* (*Dalbergia sissoo*), the teak (*Tectona grandis*) and the *sal* (*Shorea robusta*). It is not possible to draw any definite conclusions from the data hitherto obtained and further data extending over another 15 years will have to be collected to form some definite conclusions. Nevertheless, the present data appear to indicate that the soil has not undergone any change in its physical character during the past 5 years. Chemical analyses show that nitrates are now found in greater concentration in the first 3″ especially in the teak and the *shisham* areas and that the amount of organic nitrogen in the *sal* and the *chir* areas has fallen since 1927. The organic matter also is lower in all the areas except in the *shisham* where a slight increase is noticeable. The top surface of the soil which was compact during the agricultural period has now become porous but at depths of 18″ and below no change has occurred. These results are evident from the tables given below.

Average figures for samples taken in the month of March 1932 from the four corners of the same area, corresponding figures for March 1927 are given in brackets.

Depth.	Volumetric Composition.				Nitrates.	Organic nitrogen (Kjeldahl).	Organic matter.	Moisture.
	Water.	Air.	Water and air.	Soil.				
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
				Sal Area.				
0"-3"	17·1	32·7	49·8	50·2	·00016	·071	3·15	13·26
	(24·7	23·1	47·8	52·2	·00011	·132	3·09	17·50)
3"-9"	18·6	27·4	46·0	54·0	·00009	·064	3·45	13·95
	(31·1	12·2	43·3	56·7	·00006	·099	4·13	20·34)
9"-18"	25·0	28·2	53·2	46·8	·00009	·071	4·60	22·43
	(37·6	13·1	50·7	49·3	·00006	·116	5·19	28·28)
18"-36"	25·6	27·5	53·1	46·9	·00009	·069	4·65	25·90
	(35·2	21·2	56·4	43·6	·00006	·102	5·00	29·87)
				Chir Area.				
0"-3"	14·7	32·6	47·3	52·7	·00017	·093	4·31	10·73
	(29·3	16·3	45·6	54·4	·00011	·118	4·69	19·98)
3"-9"	19·2	26·1	45·3	54·7	·00007	·074	3·97	13·45
	(32·5	4·1	36·6	63·4	·00009	·093	4·66	19·33)
9"-18"	27·0	23·4	51·3	48·7	·00007	·081	5·24	21·39
	(35·4	7·3	42·7	57·3	·00009	·090	4·61	22·85)
18"-36"	29·8	23·0	52·8	47·2	·00006	·072	5·11	23·50
	(30·9	14·9	51·8	48·2	·00009	·093	5·61	28·36)
				Teak Area.				
0"-3"	6·4	39·8	46·2	53·8	·00030	·082	3·88	4·50
	(25·5	20·2	45·7	54·3	·00008	·087	4·42	17·37)
3"-9"	14·2	34·8	49·0	51·0	·00013	·069	4·20	10·88
	(29·1	8·5	37·6	62·4	·00008	·072	4·75	17·37)
9"-18"	19·7	33·7	53·4	46·6	·00009	·078	4·67	16·44
	(29·8	14·8	44·6	55·4	·00008	·075	5·01	19·90)
18"-36"	19·8	33·0	52·8	47·2	·00008	·060	4·72	18·90
	(25·5	26·1	51·6	48·4	·00008	·069	4·99	19·47)
				Shisham Area.				
0"-3"	12·5	38·1	50·6	49·4	·00044	·073	3·91	9·96
	(7·4	38·9	46·3	53·7	·00010	·083	3·86	4·98)
3"-9"	14·5	35·8	50·3	49·7	·00017	·068	4·33	11·75
	(23·2	20·2	43·4	56·6	·00008	·064	4·39	15·23)
9"-18"	19·4	34·2	53·6	46·4	·00013	·077	5·39	17·57
	(26·4	25·0	51·4	48·6	·00013	·081	4·92	22·10)
18"-36"	19·3	32·7	52·0	48·0	·00010	·065	5·22	21·79
	(21·0	28·9	44·9	55·1	·00013	·054	3·83	14·46)

Mechanical analysis of the composite samples ; corresponding figures for 1927 are given in brackets.

	Sal area				*Chir* area.				Teak area.				*Shisham* area.			
	0"-3"	3"-9"	9"-18"	18"-36"	0"-3"	3"-9"	9"-18"	18"-36"	0"-3"	3"-9"	9"-18"	18"-36"	0"-3"	3"-9"	9"-18"	18"-36"
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Coarse sand .	34·3	28·2	21·0	25·6	16·9	15·3	9·0	8·7	29·2	27·5	23·7	28·1	34·5	30·9	23·7	23·6
	(33·9	31·2	23·0	23·9	14·8	14·1	10·9	9·6	29·5	25·5	25·3	28·0	36·8	32·6	28·0	26·1)
Fine sand .	29·4	26·5	23·0	22·9	22·3	23·5	23·4	25·6	24·0	21·9	20·0	22·1	22·0	20·1	18·2	18·3
	(25·3	25·2	20·2	22·4	22·3	21·4	21·4	24·1	23·4	21·7	19·9	20·6	21·5	20·1	16·9	16·1)
Silt . . .	16·0	16·9	18·2	17·3	28·0	27·2	21·9	25·3	21·6	20·9	17·2	18·6	21·2	19·8	17·8	17·5
	(19·5	17·9	21·1	20·5	30·1	29·1	28·1	27·8	22·1	18·8	18·9	17·0	20·9	22·1	20·2	19·1)
Fine silt . .	13·6	19·2	26·7	25·5	25·9	26·4	31·4	29·4	18·5	21·1	26·7	25·0	17·1	19·9	27·2	27·9
	(15·0	16·8	20·8	20·9	22·7	24·4	27·6	27·3	17·2	22·8	24·6	22·3	14·6	18·6	25·0	26·1)
Clay . . .	6·7	9·2	11·1	8·7	6·9	7·6	14·3	11·0	6·7	8·6	12·4	11·2	5·2	9·3	13·1	12·7
	(6·3	8·9	14·9	12·3	10·1	11·0	12·0	11·2	7·8	11·2	11·3	12·1	6·2	6·6	9·9	12·6)

3. *Miscellaneous enquiries.*

Composition for reconditioning abrased spike holes.—Reports on the sleepers that were treated with "Fridera" in 1931 have been satisfactory and this has led to further trials for which the Indian State Railways have been supplied with about 10,000 pounds of the material which it is hoped would be sufficient for about 60,000 spike holes. The following remarks of the Chairman of the Seventh Annual Meeting of the Sleeper Pool Committee held in New Delhi in November 1932 may be quoted "I notice that my predecessor referred in 1930 to a composition for filling spike holes in sleepers to prevent 'spike-killing.' This composition has now been patented in many parts of the world by the inventor, under the name of 'Fridera.' The trials in the line have so far proved satisfactory, the composition having survived two hot weathers in the Punjab. Orders for about 5 tons have been received from most of the Indian Railways, and arrangements for manufacture on a commercial scale by the Jallo Subsidiary Industries Co. at Jallo, in the Punjab have been concluded by the inventor."

A large number of analyses of various substances were undertaken on behalf of the officers of the Institute and forest officers. Particular mention may be made of the following :—

Casein cements, glues, essential oils, tannins, *katha*, soils, drugs, etc.

4. *Publications.*

See Appendix I.

APPENDIX I.

PUBLICATIONS OF 1932-33.

Serial No.	Title of Publication.	Author.
	FOREST RECORDS.	
1	Immature Stages of Indian Coleoptera (10) (Anthribidae). April 1932.	J. C. M. Gardner.
2	Treatment of *Babul* (*Acacia arabica*) in Berar. May 1932.	S. A. Vahid.
3	Entomological Investigations on the Spike Disease of Sandal (*Santalum album*)—Part I.—An Introductory Survey of the Problem. August 1932.	C. Dover.
4	Immature Stages of Indian Coleoptera (11) (Platypodidae). October 1932.	J. C. M. Gardner.
5	The Sutlej Deodar.—Its Ecology and Timber Production. January 1933.	R. M. Gorrie.
6	Provisional Volume Tables and Diameter Growth Curve for *Semal* (*Bombax malabaricum*) in the Central Provinces. November 1932.	I. D. Mahendru.
7	Branch Smallwood Tables for *Shorea robusta, Tectona grandis, Pinus excelsa* and *P. longifolia*. December 1932.	....
8	New Cerambycidae from India (Coleoptera). January 1933	W. S. Fisher.
9	The Importance of the Origin of Seed used in Forestry. January 1933.	H. G. Champion.
10	Provisional Volume Tables and Diameter Growth Curves for *Holoptelea integrifolia* (*kanju*) and *Trewia nudiflora* (*gutel*). February 1933.	I. D. Mahendru.
11	Interim Report on Work under Project No. 2, Strength Tests of Timbers in Structural Sizes. June 1933.	L. N. Seaman.
12	Immature Stages of Indian Coleoptera (12) (Carabidae). June 1933.	J. C. M. Gardner.
13	Immature Stages of Indian Coleoptera (13) (Bostrychidae). August 1933.	Do.
14	Multiple Yield Tables for Deodar. In Press . .	H. G. Champion and I. D. Mahendru.
15	Third Interim Report on Project No. 1.—The Physical and Mechanical Properties of Woods Grown in India. In Press.	V. D. Limaye.
16	Entomological Investigations on the Spike Disease of Sandal (2)—(Scolytidae and Bostrychidae). August 1933.	C. F. C. Beeson.
17	Do. (3)—(Membracidae). July 1933.	W. D. Funkhouser.
18	Do. (4)—(Cercopidae). July 1933.	V. Lallemand.
19	Do. (5)—(Brenthidae and Lycidae). July 1933.	R. Kleine.
20	Do. (6)—(Anthribidae). July 1933.	Karl Jordan.
21	Do. (7)—The Genus Exocentrus, Cerambycidae. July 1933.	W. S. Fisher.

APPENDIX I—*contd.*

Serial No.	Title of Publication.	Author.
22	Entomological Investigations on the Spike Disease of Sandal (8)—(Carabidae). In Press.	H. E. Andrewes.
23	Do. (9)—(Neuroptera). July 1933.	Nathan Banks.
24	Do. (10)—(Melasidae and Elatridae). August 1933.	E. Fleutiaux.
25	Do. (11)—(Fulgoridae). In Press.	N. C. Chatterjee.
26	Investigations on the infestation of *Peridermium himalayense* on *Pinus longifolia*, Part II. In Press.	K. Bagchee.
	FOREST BULLETINS.	
27	Identification of Important Indian Sleeper Woods. September 1932.	K. A. Chowdhury.
28	The Problem of the Pure Teak Plantation. October 1932.	H. G. Champion.
29	Calorific Values of some Indian Woods. October 1932	S. Krishna and S. Ramaswami.
30	List of Trees and Shrubs for the Kashmir and Jammu Forest Circles, Jammu and Kashmir State. March 1933.	W. J. Lambert.
31	Testing and Selection of Commercial Wood Preservatives. In Press.	S. Kamesam.
	OTHER PUBLICATIONS.	
32	Progress Report of Forest Research Work in India, for 1930-31. June 1932.	....
33	The Progress of Forest Research in India, 1931-32—Part I.—The Forest Research Institute. September 1932.	....
34	The Progress of Forest Research in India, 1931-32—Part II.—Forest Research in the Provinces. February 1933.	....
35	List of Seeds offered in Exchange, Botanist's Branch. November 1932.	....
36	Annual Return of Statistics relating to Forest Administration in British India for 1931-32. July 1933.	....
37	Guide to the Forest Research Institute. In Press	....
38	Triennial Programme of Research Work 1933-36. August 1933.	....

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS.

Silviculture.

Champion, H. G. . . Note on dying off of *Gmelina arborea* in plantations. (*Indian Forester*, February 1932.)

Champion, H. G. . . Mode of growth of *Alstonia scholaris*. (*Indian Forester*, March 1932.)

Champion, H. G. . . European silvicultural research, Parts I to V. (*Indian Forester*, October 1932 to March 1933.)

Gorrie, R. M. . . The practical use of ecology. (*Indian Forester*, December 1932.)

Gorrie, R. M. . . The better utilisation of forests for grazing. (*Indian Forester*, March 1933.)

Deogun, P. N. . . Nursery manuring experiments. (*Indian Forester*, May 1933.)

Botany.

Parker, R. N. . . .	A Burmese climbing bamboo. (*Indian Forester*, January 1932.)
Raizada, M. B. . .	New Indian species of forest importance, Part 8. (*Indian Forester*, March 1932.)
Parker, R. N. . . .	Casuarina root nodules. (*Indian Forester*, April 1932.)
Parker, R. N. . . .	*Cryptocaria amygdalina* and *floribunda*. (*Indian Forester*, August 1932.)
Parker, R. N. . . .	The genus *Cymbopogon* in N. W. India. (*Indian Forester*, December 1932.)
Parker, R. N . . .	*Vitis rugosa* Wall and *Vitis* spp. (*Indian Forester*, February 1933.)

Entomology.

Appana, M., Chatterjee, N. C., and Dover, C.	Investigations on the spike-disease of sandal. Reports VI and VII, 1933. The Bangalore Press, Bangalore City.
Beeson, C. F. C. . .	*Lyctus* beetles in India. (*Indian Forester*, Vol. LIX, 1933, pp. 158-164.)
Bhatia, B. M. . .	An effective method of disposing of rats. (*Indian Forester*, Vol. LVIII, 1932, pp. 587-588.)
Chatterjee, S. N. . .	Identification of teak defoliators in the field. (*Indian Forester*, Vol. LVIII, 1932, pp. 689-691.)
Chatterjee, S. N. . .	*Python molurus*. (*Indian Forester*, Vol. LVIII, 1932, pp. 327-328.)
Dover, C. . . .	A social spider as a pest of mango trees. (*Indian Forester*, Vol. LVIII, 1932, pp. 615-616.)
Gardner, J. C. M. . .	The larva of *Catapiestus indicus* Fairm. (*Coleoptera*: Tenebrionidae). (*Proceedings of the Entomological Society of Washington*, Vol. 34, 1932, No. 8, pp. 142-145.)
Gardner, J. C. M. . .	The early stages of two Indian weevils (Col. Curculionidae). (*Stylopes*, Vol. 2, 1933, pp. 81-85.)
Mathur, R. N. . .	The leaf curl of cotton in garden *Zinnias* in North India. (*Ind. Journ. Agric. Sci.* III, pt. I, Feb. 1933, pp. 89-96, Pl. IX & X.)
Mathur, R. N. . .	On the bionomics of *Odontomyia cyanea* Brunetti. (*Ind. Journ. Agric. Sci.* III, April 1933, Pl. XXV and XXVI.)

Economic.

Chowdhury, K. A. . .	The liability of Indian woods to *Lyctus* attack. (*Indian Forester*, March 1933.)
Kapur, S. N. . . .	Report on the air seasoning experiments on softwood railway sleepers in the Punjab. (*Railway Board Quarterly Technical Bulletin* III—29—of April 1933.)
Popham, F. J. . .	Durability tests on untreated Indian timbers. (*Indian Forester*, January 1932.)
Seaman, L. N. . .	Safe working stresses for Indian timbers. (*Indian Forester*, January 1932.)
Seaman, L. N. . .	Distinguishing *in* and *kanyin* timbers. (*Indian Forester*, July 1932.)
Popham, F. J., and Kamesam, S.	A new wood preservative, the Falkamesam process. (*Indian Forester*, April 1932.)
Seaman, L. N. . .	Will something else do? (*Indian Forester*, December 1932.)

Chemistry.

Krishna, S., and Ghose, T. P.	Seeds of *Vateria indica* as a source of vegetable tallow. (*Indian Forester*, February 1932.)
Krishna, S., and Ghose, T. P.	Actinodaphnine—An alkaloid from *Actinodaphne hookeri*, Meissn. (*Journ. Ind. Chem. Soc.* Vol. IX, 429.)
Ghose, T. P., and Krishna, S.	Vasicine. (*Journ. Chem. Soc.* 1932, p. 2740.)
Puntambekar, S. V., and Krishna, S.	Storage of *Strychnos nux-vomica* seeds. (*Quarterly Journ. of Pharmacy and Pharmacology*, Vol. V, No. 4, 1932, p. 633.)
Ghose, T. P. . . .	Preliminary chemical examination of *Dodonaea viscosa*, Linn. (*Indian Forester*, 1933, p. 78.)
Krishna, S., and Varma, B. S.	Indian *Artemisias*. (*Quarterly Journ. of Pharmacy and Pharmacology*, Vol. VI, No. 1, 1933.)

APPENDIX II.

PUBLICATIONS OF THE FOREST RESEARCH INSTITUTE, DEHRA DUN, AVAILABLE FOR SALE.

	Price (exclusive of packing, postage, etc.). Rs. A. P.
I.—BULLETINS (OLD SERIES).	
4. *Ficus elastica:* its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
6. Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
II.—LEAFLETS—(*All out of print*).	
III.—PAMPHLETS.	
6. Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	1 0 0
8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia	0 10 0
9. Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author	0 10 0
10. Note on Burmese Leza Wood (*Lagerstroemia tomentosa*, Presl.), by R. S. Troup	0 2 0
16. Note on the Best Season for Coppice Fellings of Teak (*Tectona grandis*), by R. S. Hole	0 4 0
IV.—BULLETINS (NEW SERIES).	
3. Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0 4 0
6. Memorandum on the Oil-Value of Sandalwood, by Puran Singh	0 2 0
7. Note on the Chemistry and Trade Forms of Lac, by the same author	0 3 0
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APPENDIX III.

Statement showing Officers in Charge of Branches and Sections during the year 1932-33.

Branch.	Officer-in-Charge.	Section.	Officer-in-Charge.	From	To
Silviculture .	Mr. H. G. Champion, Silviculturist.	....	....	1-4-1932	31-3-1933
		Experimental .	Mr. P. N. Deogun	1-4-1932	31-3-1933
		Statistical .	Mr. I. D. Mahendru	1-4-1932	31-3-1933
Botany . .	Mr. R. N. Parker, Forest Botanist.	....	....	1-4-1932	16-10-1932
	Mr. C. E. Parkinson, Forest Botanist.	....	....	17-10-1932	31-3-1933
		Mycology .	Dr. K. D. Bagchee	1-4-1932	31-3-1933
Economic .	Capt. H. Trotter, Forest Economist.	....	....	1-4-1932	31-3-1933
		Minor Forest Products.	Mr. F. D. Ardagh	1-4-1932	30-4-1932
			(Capt. H. Trotter)	1-5-1932	31-3-1933
		Timber Testing	Mr. L. N. Seaman	1-4-1932	27-3-1933
			(Mr. V. D. Limaye)	28-3-1933	31-3-1933
		Wood Preservation.	Mr. S. Kamesam	1-4-1932	31-3-1933
		Seasoning .	Dr. S. N. Kapur .	1-4-1932	28-2-1933
			(Mr. A. Rehman).	1-3-1933	31-3-1933
		Paper Pulp .	Mr. M. P. Bhargava.	1-4-1932	31-3-1933
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1932	23-5-1932
			(Capt. H. Trotter)	24-5-1932	19-6-1932
			Mr. K. A. Chowdhury.	20-6-1932	31-3-1933
		Wood Workshop.	Mr. W. Nagle .	1-4-1932	31-3-1933
Entomology .	Mr. J. C. M. Gardner, Offg. Forest Entomologist.	....	....	1-4-1932	16-10-1932
	Dr. C. F. C. Beeson, Forest Entomologist.	....	....	17-10-1932	31-3-1933
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1932	31-3-1933
Chemistry .	Dr. S. Krishna, Bio-Chemist.	....	....	1-4-1932	31-3-1933

APPENDIX IV.

ANNUAL FORM No. 24.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure of the Branches during 1932-33.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4		6	7	8
REVENUE.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
V.—Miscellaneous—							
(*b*) Other sources . .	5,399	659	167	105	2,925	28	9,283
(*d*) Sale of timber and furniture from Seasoning and Wood Workshop Depôt.	..	..	..	..	256	..	256
Total Revenue .	5,399	659	167	105	3,181	28	9,539
EXPENDITURE.							
A.—Conservancy, Maintenance and Regeneration—							
C.—Live stock, stores, tools and plant—							
C. 1.—Purchase of stores, tools and plant.	419	1,154	470	416	2,034	165	4,658
C. 2.—Communications and Buildings, New Work—							
(*a*) Roads and bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other Works . .	..	..	..	..	..	..	..
C. 3.—Communications and Buildings, Repairs and Maintenance—							
(*a*) Roads and Bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other charges . .	675	..	..	..	..	..	675
C. 4.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	9,060	1,380	2,959	1,893	3,611	367	19,278
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	6,877	..	6,877
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	437	9,035	1,864	11,336
(4) Other charges . .	1,120	2,797	688	911	16,174	486	22,176
Total A.—Conservancy, Maintenance and Regeneration.	11,280	5,331	4,117	3,659	37,731	2,882	65,000

APPENDIX IV—*contd.*

ANNUAL FORM NO. 24—*contd.*

FOREST RESEARCH INSTITUTE—*contd.*

Summary of Revenue and Expenditure of the Branches during 1932-33—contd.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*contd.*							
B.—Establishments—							
I.—Pay of Officers—							
Non-voted—							
(*a*) Conservators . .	..	..	15,674	..	..	..	15,674
(*b*) Superior officers .	11,666	13,687	..	18,018	17,412	..	60,783
Voted—							
Superior officers . .	86	13,290	10,699	16,262	1,01,248	19,946	1,70,531
II.—Pay of Establishment—							
(*a*) Subordinate forest and depôt establishments.	..	3,328	1,375	6,577	3,033	1,572	15,885
(*b*) Office establishments .	23,106	17,390	7,665	15,860	90,754	4,022	1,58,797
III.—Allowances—							
Cost of passage (Central)—							
Non-voted . . .	..	..	..	..	..	..	..
(*b*) House-rent and other allowances—							
Non-voted . . .	..	..	..	..	..	..	..
Voted	489	..	..	..	..	..	489
Travelling allowances—							
(*c*) Conservators, Non-voted	..	..	356	..	..	..	356
(*d*) Superior officers—							
Non-voted . . .	..	2,375	..	1,209	82	..	3,666
Voted	..	484	1,381	2,423	590	222	5,100
(*e*) Subordinate forest and depôt establishments.	..	..	13	240	..	..	253
(*f*) Office establishments .	132	921	151	686	—172	..	1,718
Cost of passage to America of officers for training, etc.	..	..	..	..	..	..	..

APPENDIX IV—*concld.*

ANNUAL FORM No. 24—*concld.*

FOREST RESEARCH INSTITUTE—*concld.*

Summary of Revenue and Expenditure of the Branches during 1932-33—concld.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*concld.*							
IV.—Contingencies—							
(*a*) Stationery . . .	209	8	44	..	19	..	280
(*b*) Carriage of records and tents.	10	457	251	142	..	..	860
(*c*) Rents, rates and taxes .	5,021	182	450	..	89	..	5,742
(*d*) Pay of menials . .	2,611	..	..	420	..	..	3,031
(*e*) Official postage . .	602	315	621	320	254	50	2,162
(*f*) Sundries . . .	15,021	838	1,521	2,725	1,890	2,508	24,503
(*g*) Clothing and uniform .	389	75	38	138	326	50	1,016
(*h*) Telephone . . .	1,084	279	290	246	1,553	128	3,580
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-voted).	412	943	380	1,200	708	..	3,643
Payment on account of medical treatment.	164	..	..	..	..	..	164
Total B.—Establishments .	61,002	54,572	49,909	66,466	2,17,786	28,498	4,78,233
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	72,282	59,903	54,026	70,125	2,55,517	31,380	5,43,233
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	597	..	..	2,080	..	..	2,677
Surplus or deficit . . .	—67,480	—59,244	—53,859	—72,100	—2,52,336	—31,352	5,36,371

NOTE.—The figures given in this statement have been prepared in the President's office and are based on the summary of Revenue and Expenditure for March 1933 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items.

R. M. GORRIE,
for *President*,
Forest Research Institute and College.

MGIPC—S6—III-2-89—13-9-33—400.

12 JAN. 1934

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Forest Research in India, 1932-33.

PART II.—PROVINCIAL REPORTS.

CHAPTER I.

GENERAL.

A large variety of research has again been undertaken in the provinces, mostly in co-operation or in consultation with the Forest Research Institute, but also independently to solve the more pressing local problems. A number of results of very considerable value are recorded, and it is only to be regretted that work had to be restricted owing to the continued need of economy. A programme of work at the Forest Research Institute for the three years 1933-36 has now been drawn up with the assistance of provincial forest authorities and, if programmes of research were drawn up in all of the provinces and circulated, invaluable collaboration would be ensured.

In Assam extensive experiments were made with the regeneration of *sal* (*Shorea robusta*) and *hollock* (*Terminalia myriocarpa*), and very encouraging results are reported regarding the response of regeneration in evergreen forests to tending operations after exploitation. Similarly in the Chittagong division of Bengal removal of the lower cover in *gurjan* (*Dipterocarpus turbinatus*) forest has helped existing regeneration, while appreciable opening of the general canopy has been followed by a most undesirable development of evergreen undergrowth and bamboos. The best time for sowing *Tephrosia* seed to provide shade for *gurjan* in the following hot weather has been found to be at the last cleaning of the paddy crop with which the tree is grown; *Tephrosia* seed has retained its full fertility for 3 years. *Cassia tora* and Napier grass (*Pennisetum purpureum*) are reported as promising new cover crops with *sal*, and after considerable experiment and observation thinning practice in young *sal* plantations has been tentatively standardised. A light crown thinning after six growing seasons is now prescribed, a second thinning to be considered after 11 seasons.

In Bihar and Orissa conversion to the Uniform System of working is being replaced by the Selection System in the damper types of *sal* (*Shorea*

134463

robusta) forest in the Puri and Angul divisions. The *sabai* grass (*Pollinidium angustifolium*) plantations are a success and the burning of bamboo forests appears to have improved production; experimental clear-felling of one half of bamboo clumps produced only half as many new culms. It is very satisfactory to note that the unofficial Forest Association is flourishing and is promoting the proper management of private forests. The experimental growing of *rosha* grass (*Cymbopogon martini*) on fire lines in Bombay is promising and the economic rotation of poplar (*Populus euphratica*) coppice has been fixed at 6 years. In Burma the preparation of working plans remains severely curtailed until finances recover. Unsatisfactory regeneration of *in* (*Dipterocarpus tuberculatus*) was obtained with and without fire protection where the seedlings were scattered, and preliminary results of the All-India teak seed investigation showed the Travancore and Nilambur origins to make the best start. In Coorg attention was largely devoted to sandal; *Erythrina* as a host plant is found to attract game and *Cassia siamea* seems best suited.

In the Central Provinces the post of Superintendent of Working Plans was abolished and forest grazing continues to be one of the chief matters for consideration. All reserved forests are being classified according to their relative importance for timber and fuel or grazing, and a policy will be defined when this work is complete. Complete absence of, or closure to, grazing is found to hinder teak regeneration apart from increasing the risk of fire. Agri-silvicultural work in Berar has lost its popularity owing to the agricultural slump. Madras has adopted modern technique, permitting of statistical analysis of experimental data, with very satisfactory results. Investigations of teak plantation methods have been specially studied in this way, and the great advantages of pre-monsoon planting demonstrated under the favourable moisture conditions prevalent in most districts; April planting gives two or three times the height growth of June planting with no increase of casualties. The burning back of teak in the first hot weather showed a 24 per cent. advantage in height growth in the second season; soil working procedure indicated the superiority of the present Nilambur practice. Underplanting with the bamboo *Cephalostachyum pergracile* has been very successful, and underplanting in evergreen forest with *Mesua* and *Calophyllum elatum* was quite promising. Good results were obtained from the artificial stocking of felling gaps in mixed deciduous forest, but in the dry forests of Chittoor the shading of sowings was of no avail.

As a preliminary to regeneration investigations a detailed study was made in the Punjab of the types of forest containing spruce and silver fir, and variations of seed and seedling development of blue pine and deodar were found with altitude and rainfall. Methods of hastening the

germination of *olive* (*Olea cuspidata*) were examined and soaking in acid or alkali found best. Progress is reported with the artificial regeneration of poplar (*Populus euphratica*) and tamarisk (*Tamarix articulata*), while great success has again been obtained with eucalyptus (*Eucalyptus rostrata*) in Chhanga Manga plantation. In the North West Frontier Province it has been confirmed that weeding young natural regeneration of blue pine is definitely harmful and results in increased drought mortality : partial shade from an overhead canopy is beneficial at that stage. Ash is being grown more extensively and here too excessive weeding has to be avoided. The United Provinces have undertaken further intensive studies of *sal* natural regeneration problems though continued extension of *taungya* (agri-silvicultural) methods are recorded. Similar methods are being tried with quick growing species on poor culturable land to produce a larger yield of cheap firewood for use in place of cattle dung. A large scale carefully planned investigation has been started to collect reliable information on some of the practical points in resin-tapping.

In both Assam and Burma provincial herbaria are maintained and collections have been made for the systematic study of the flora. Part of a Flora of Assam is expected to be issued shortly ; some new plants of forest importance are being described and special attention is being given to the identity of forest grasses and to the *bonsums* (*Phoebe* spp.) a difficult genus of the *Lauraceae*. Abolition of the post of Forest Botanist in Burma is to be regretted since a collection of authentic timber specimens was being linked with a botanical collection. In the Central Provinces a botanical survey of parts of the Betul division has been started, in Bihar and Orissa attention is drawn to damage to *sal* (*Shorea robusta*) by the fungus *Fomes tricolor*, and in the Central Provinces to fungus damage to lac and to *babul* (*Acacia arabica*).

Entomological research in Burma was handicapped by a reduction of staff which involved placing the Forest Zoologist in charge of a territorial division. The life histories of teak insects were continued in the permanent observation areas and in the insectaries. In the Central Provinces the importance of keeping a watch on the abundance of the *sal* borer is recognised and the use of trap-trees as a precautionary measure has become a regular practice.

Trade depression is again a feature of the reports on the utilisation of forest produce, but a number of efforts to find new or more extensive markets give promise of success. In Assam a small demand for impregnated wood has been created, and the shrub *Derris elliptica* which yields rotenone is believed to have been found. Bengal records the more extended use of plywood and looks forward to large quantities of bamboo being used as pulp. Birch (*Betula alnoides*) wood was proved to have valuable properties and it is hoped to develop a market for *gurjan* (*Dipterocarpus* spp.) The rail and river freights are still high

and the dishonest substitution of inferior timbers by some traders will sooner or later handicap expansion of trade. In Bihar and Orissa broad gauge and metre gauge *sal* railway sleepers were selling for Rs. 4-12 and Rs. 2 respectively, and at these prices there are signs of an up-country demand for the timber. The growing of lac has been restricted owing to the very low prices obtained, but on the other hand the demand for bamboos for pulp is increasing. The experimental cultivation of lac in Bombay seems ill-timed. The Forest Department in Burma have issued several interesting publications and the report records valuable results in kiln seasoning timbers. The use of bamboos not transported by water as dunnage in ships has led to cargoes of timber being attacked by borers. In the Central Provinces the demand for myrobalans was good and the hand-sawing of otherwise waste timber has been found profitable. The centralisation of timber sales has been attended by very satisfactory results.

In Madras the total value of the sales made by the Forest Utilisation Officer increased to Rs. 9,60,000 as against Rs. 7,94,000 in the previous year. In the Punjab the best seasoning of railway sleepers has been obtained by the 1 and 9 method of stacking, and the outturn of *Ephedra* in the Multan division has been estimated at 400 maunds per annum. The United Provinces are also an exception to the usual reports of shrinking markets as their sales of *sal* increased from 78,000 to 84,000 tons, while sales of *pine* (*Pinus longifolia*), *semal* (*Bombax malabaricum*) for the match industry and deodar all increased in volume. The output of resin also increased from 66,000 to 87,000 maunds, and it is interesting to note that in the last 10 years the cash receipts in the United Provinces from this industry have been Rs. 50 lakhs ; the expenditure of Rs. 30 lakhs consists largely of wages paid to villagers in the Kumaon hills.

In the Punjab the varying loss of water from soils according to the vegetation and the hydrogen-ion concentration of a number of soils were matters of investigation.

The reports received from the provinces follow, but some have been summarised or abridged. A list of officers employed exclusively on research, and lists of publications in the provinces and at the Forest Research Institute, form appendices.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

ASSAM.

I.—Experimental Silviculture.

(1) *General.*

As the financial condition of the Province did not improve the post of Silviculturist had to remain vacant during the year, but Mr. A. Das, I.F.S., who has been attached throughout the year to the Direction division for completing the Flora of Assam, carried on the Silviculturist's work in Upper Assam. Almost all experimental plots and sample plots were visited by him during the year, his inspection being mainly confined to ensuring that maintenance was being carried on in accordance with previous prescriptions.

The Central Silviculturist visited the *sal* (*Shorea robusta*) forests of Kamrup and Goalpara divisions ; he was accompanied by representatives from Bengal and local Divisional Forest Officers.

(2) *Natural Regeneration.*

In Sadiya division the quadrant experiments with a view to obtaining natural regeneration of *hollock* (*Terminalia myriocarpa*) referred to in last year's report have continued to give considerable success. An area of 14 acres now contains excellent regeneration averaging 15' in height, age 2 years. Further similar quadrant experiments have been started. In this connection attention is invited to the interesting article by Mr. A. R. Thomas, I.F.S., in *The Indian Forester* of June 1933. The problem of thinning now calls for careful consideration.

In Sibsagar division an experimental area of 25 acres in the Sola reserve was laid out with a view to studying the effect of climber cutting on the progress of natural regeneration in typical plains evergreen forest.

In Sylhet division experiments for regenerating *jam* (*Eugenia*) and *gurjan* (*Dipterocarpus turbinatus*) continue on a small scale. In Cachar division a suitable area containing both hilly and low land has been selected for study of regeneration of the principal species and seed trees have been marked and listed. In all *sal* divisions experimental plots are being maintained by the Divisional Forest Officers.

In Kamrup it is reported that in Periodic Block I areas there is a very appreciable difference in height, and leaf growth of seedlings

where the soil had been lightly hoed as against areas which had merely been cleared of undergrowth. In Darrang the *sal* regeneration in 10 acres of the Garumari reserve referred to in last year's report continues to be satisfactory. In Lakhimpur areas in which tending operations following exploitation had been carried out, the advance growth particularly of *hollong, nahor* (*Mesua ferrea*) and *sam* (*Artocarpus chaplasha*) is very encouraging.

(3) *Seed.*

As suggested in last year's report this has been a very good year for *sal* in Kamrup. It is reported however to have been poor in Darrang and Nowgong. Most of the other more valuable species seeded well.

(4) *Nursery Work.*

Two ounces each of *Cinchona ledgeriana* and *C. succirubra* were obtained from Maungpoo and 3 new nurseries were established in the Khasi Hills, Garo Hills and Mikir Hills (Sibsagar). The *Cinchona ledgeriana* nursery on Tura Top laid out last year was maintained. The biggest seedlings now measure 11″ but the average is only about 4″ ; condition is healthy.

(5) *Artificial Regeneration.*

In both Lakhimpur and Sibsagar plantations and *taungyas* of *hollock* and *ajhar* continue to show mo t promising results and may be said to have passed the experimental stage ; the principal concern now is to decide the extent and frequency of thinning required. The total area under plantations and *taungyas* at the beginning and close of the year was 12,689 and 12,676 acres respectively.

In Sadiya division Plot No. 1 *bola* (*Morus laevigata*), 2 acres, now 5 years old, is reported to be fully stocked. In Sibsagar division Plot No. 2 of *jutuli* (*Altingia excelsa*), *gonserai* (*Cinnamomum eccidodaphne*) and *phulsapa* (*Manglietia insignis*), the *jutuli* is reported to be thriving. As regards *hollock* and *ajhar* (*Lagerstroemia flos-reginae*) plantations, the experimental stage is now passed so far as establishment is concerned but tending and thinning require careful study. Regeneration of *hollong* (*Dipterocarpus macrocarpus*) and *amari* (*Amoora wallichii*), which has been under experiment since 1921, has not yet produced any final conclusions—development is reported to be slow. In Sylhet division *sal* sowings under *boga medeloa* (*Tephrosia candida*) were again tried ; germination was reported to be 100 per cent. and results appear promising. Broadcast sowings of *jarul* (*Lagerstroemia flos-reginae*) in strips were tried in several plots with varying success ; transplanting from nursery appeared to give rather better results. In Kamrup division 8 research

plots were started, lines were hoed and *sal* either sown in lines or broadcast, but results at present appear to be indistinguishable ; weeding varying in quantity was carried out, and results are being recorded. In Nowgong division the *sal* experiment over 20 acres, to ascertain if the cost of weeding could be reduced by burning, is reported unsatisfactory due to the influx of *Eupatorium*. In Lakhimpur division thinning was carried out in 27·5 acres of experimental *hollock* areas to give an approximate spacing varying from 3′×3′ to 2′×2′ : the ages of the plots in which this was carried out varied from 3 to 5 years.

(11) *Miscellaneous.*

In the *Cinchona ledgeriana* plantation in the Mikir Hills referred to in last year's report the condition of the plants now about 4 years old is reported to be promising and a portion is now suitable for harvesting (intermediate yield). Steps are being taken to collect bark for submission to the Maungpoo factory for analysis of quinine content. About 40 plants have been damaged by wild elephants. It is of interest to note that some of the plants which were transplanted as *Cinchona ledgeriana* proved to be hybrid (*Cinchona ledgeriana* × *Cinchona succirubra*) and it therefore appears that natural hybridisation cannot be prevented in the Maungpoo plantation unless the species are carefully isolated.

Mezankori (*Litsea citrata*) which was put out in Hollongapar (Sibsagar) is now about 2 years old and on an average 10′ high ; their condition is satisfactory although stems have been rubbed by deer in some cases.

The *tung* oil (*Aleurites fordii*) seedlings mentioned last year are doing well ; their height varies from 1′ to 6′ 8″.

II.—Working Plans and Statistics.

The post of the second Working Plan Officer remained vacant during the year. The Working Plan for the sub-montane forests of the Lakhimpur and Sibsagar divisions was published and the financial results of the first year's sales have been most satisfactory, but it is feared that with reduced sleeper contracts from the Assam Bengal Railway, future working will have to be considerably curtailed. The draft plan for the plains reserves of the Lakhimpur division south of the Brahmaputra was under consideration and the field work in connection with the Sadiya working plan terminated just after the close of the year. In the Sylhet division the preliminary Patharkandi Range Timber Working Scheme, 1933-35, was prepared and the *Muli* Bamboo (*Melocanna bambusoides*) Working Scheme, 1930-34, was reported to be working satisfactorily.

Under the continued trade depression and financial stringency the provisions of existing plans are unavoidably being restricted. Sample plots were maintained.

BENGAL.

I.—Experimental Silviculture.

(1) *General.*

Mr. C. K. Homfray, Deputy Conservator of Forests, was in charge throughout the year. The *sal* investigation party, consisting of Messrs. Smythies, Champion, Mooney and De, visited the Province during January. All *sal* divisions of Northern Bengal and the Bhowal forests of Dacca-Mymensingh were visited. The Conservator of Forests, Northern Circle, and the Provincial Silviculturist toured with the party, and afterwards accompanied the Central Silviculturist on a tour of the *sal* forests of the Kamrup and Goalpara divisions of Assam.

Routine silvicultural work was carried out in both northern and southern ranges in accordance with the programme of work laid down.

(2) *Natural Regeneration.*

(*a*) *Sundarbans species.*—Fenced plots in the mangrove forests of the Sundarbans division have been under observation for some time in order to note the effect of deer-grazing on the natural regeneration of the more important species. Up to date it has been proved that deer do a considerable amount of damage, especially to *dhundal* (*Carapa obovata*) and *goran* (*Ceriops roxburghiana*). In order to obtain figures for the rate of growth of the principal species of a known age, up to 200 seedlings of each species in the plots have been numbered, and periodic measurements will be taken.

(*b*) *Dipterocarpus spp.*—Experiments in natural regeneration and natural-*cum*-artificial regeneration of *D. turbinatus* and *D. costatus* were continued in the Chittagong and Cox's Bazar divisions. A further plot was laid out this year to discover the best method for aiding natural regeneration. Seeds of these two species were (i) broadcasted without hoeing, (ii) broadcasted with hoeing and (iii) notched, a process of making a hole with the point of a *dao*, placing the seed in the hole and just covering the seed with earth. Broadcasting without hoeing proved a complete failure, and the results of notching were far superior to that of broadcasting with hoeing. These species ripen just before the break of the rains, and the fact of covering the seed with earth preserves it in good condition until the rains break. Notching takes a little longer than broadcasting, but this is fully compensated for by the fact that

far less seed is required for notching owing to the greater germination per cent. obtained under this method. In plots where annual burning of the undergrowth is the only treatment carried out, it is noted that in all cases the evergreen undergrowth is gradually changing to that of *thatch* grass.

(*c*) *Evergreen Forests of the Kasalong reserve, Chittagong Hill Tracts division.*—Experiments are in progress to find out a method of raising the existing natural regeneration. The chief species concerned are *gurjan* (*Dipterocarpus pilosus*), *tali* (*Dichopsis polyantha*), *kamdeb* (*Calophyllum polyanthum*), *narikel* (*Sterculia alata*), *nageswar* (*Mesua ferrea*), *chapalish* (*Artocarpus chaplasha*) and *raktan* (*Lophopetalum fimbriatum*). In the forest young regeneration of these and less important species is to be found in large quantities from a few inches to 2 to 3 feet in height, and they appear to be surviving in a suppressed condition and putting on little, if any, growth. Plots have been laid out letting in varying degree of light, from the actual clear-felling of all stories and the cutting of the undergrowth, to the removal of the undergrowth only. After 2 years' observations it appears that wherever the 2nd and 3rd stories and undergrowth are dense, the plants are suppressed and put on no growth. In plots where the undergrowth and 3rd storey had been removed and a light thinning done in the more conjested patches in the 2nd storey, the seedlings of *tali*, *gurjan*, *raktan* and *chapalish* have put on excellent growth, but in areas where the canopy had been opened out heavily, vigorous evergreen undergrowth and bamboo-shoots come up in abundance and tend to smother the young seedlings.

(*d*) *Shorea robusta.*—In Buxa division, the experiments in burning the *sau* grass (*Pollinia ciliata*) areas, with a view to obtaining natural regeneration of *sal* were continued both in the *bhabar* tracts at Raimatong and in the foot-hills at Santrabari. So far burning appears to increase the luxuriance of the *sau*, specially in areas where the canopy is light or has been removed. At Santrabari where all species except *sal* on the ridges were cut and burnt, the *sau* grass has become so thick and high as would appear to preclude any possibility of successful natural regeneration of *sal*. *Thatch* grass, where found, does not seem at present to be extending at the expense of the *sau*. Wherever *galeni* (*Leea crispa*) occurs, it was found that it had completely suppressed the *sau* and this is a point of great interest. Experiments will be made in broadcasting seeds of *galeni* after burning the *sau*, and also in plantations raised in *sau* grass areas *galeni* will be tried as a cover crop between the *sal* lines.

(3) *Seed.*

(*a*) Seeds of exotic species for experimental purposes and seeds for plantations were supplied to divisions through the Silvicultural division.

(*b*) Seeds were also supplied to different provinces in India and several samples were sent to Russia and Japan.

(*c*) Seeds of the following valuable timber species were supplied by the Forestry Commission, England :—

Fagus sylvatica.
Picea sitchensis.
Larix leptolepis.
Pseudotsuga douglasii.
Pinus laricio.

(4) *Nursery Work.*

(*a*) Three separate silvicultural nurseries and gardens are maintained in the province.

(i) *Hazarikhil* in the Chittagong division, for experiments with indigenous species suitable for plantations in the three Chittagong divisions. The following were among the more important species taken up during the year :—

Dipterocarpus alatus, D. costatus, D. turbinatus and *D. pilosus, Swietenia macrophylla, Hopea odorata, Dichopsis polyantha, Eugenia cymosa, E. grandis, Mesua ferrea, Lophopetalum fimbriatum.*

(ii) *Sukna* in the Kurseong division for experiments with species, both exotic and indigenous, suitable for the plains and foot-hills of Northern Bengal. The following were among the more important species tried during the year :—

Ailanthus grandis, Phoebe attenuata, Polyalthia simiarum, Litsaea panamonja, Evodia meliaefolia, Adina cordifolia, Albizzia marginata, Hymenodictyon excelsum, Dalbergia latifolia, and *Lophopetalum fimbriatum.*

(iii) *Takdah* in the Darjeeling division at an elevation of 5,000′. Here experiments are being carried out with valuable exotic species obtained from different parts of the world, in order to discover valuable timber species suitable for growing at elevations between 5,000′ and 9,000′ with a rainfall of 90″ to 200″, there being, with the exception of *champ* (*Michelia excelsa*), no really valuable indigenous trees at these elevations. The following were among the more important species tried :—*Fagus sylvatica, Picea excelsa, Abies veitchii, Pinus tunburgii, Alnus incana, Abies grandis, Pinus contorta, Cupressus funebris.*

In these nurseries and gardens experiments are carried out to compare the results of direct sowing, transplanting, winter transplanting, and root and shoot cutting. In addition such data as to weight of seed, method of treating seed, germination and plant per cent. are recorded for each species. The information obtained is of immense value to this province, which depends so largely on artificial regeneration.

(*b*) The climber nursery at Sukna mentioned in last year's report was maintained by the Divisional Forest Officer, Kurseong division. Flowering climbers were collected from here and from the plantations, and altogether 43 climbers were identified by the Forest Research Institute.

(5) *Artificial Regeneration.*

(*a*) *Taungya plantations in the Chittagong and Cox's Bazar divisions.*— The following plots were laid out in order to discover the best time to sow *boga medeloa* (*Tephrosia candida*) in conjunction with field crops. The idea is to get the *boga medeloa* as tall as possible by the end of the first rains so as to afford suitable shade to the young plants during the first hot weather, and at the same time not to interfere with the growth of the *paddy* crop. The following experimental plot was, accordingly, laid out with four sub-plots each of ½ acre, with the following pres riptions :—

Sub-plot A . .	*Dipterocarpus turbinatus* in lines.	*Boga medeloa* sown broadcast at the same time as the *paddy*, *i.e.*, 1st week of May.
Sub-plot B . .	Ditto .	*Boga medeloa* sown broadcast at the time of the last cleaning of *paddy*, end of July.
Sub-plot C . .	Ditto .	*Boga medeloa* sown in hoed-up lines after *paddy* was reaped, early September.
Sub-plot D . .	Ditto .	*Boga medeloa* sown broadcast after *paddy* was reaped, early September.

Observations up to date show that in A the *boga medeloa* grew up in advance of the *paddy* and completely killed it out, also the young seedlings were suffering from suppression. In C and D, the *boga medeloa* was too small to afford shade to the young plants during the hot weather. In B, the *paddy* crop was not interfered with and it appears to be the only possible method. The results were rather patchy but where the *boga medeloa* had come up fairly well it was 3′ high by the beginning of the hot weather and was affording suitable shade to the young plants. The experiments will be repeated again this year.

(*b*) Mr. R. I. Macalpine, Divisional Forest Officer, Kalimpong division, has been trying several new species such as *angari* (*Phoebe attenuata*), *dudi lampati* (*Litsaea panamonja*), *Khuttikat* (*Saccopetalum longiflorum*), and *lapchapat* (*Polyalthia simiarum*), in his 1932 plantations both pure and in mixture. The timber of these species is in demand from the natural forest and they have never been tried in plantations before. When inspected by the Silviculturist in February all species appeared to be doing well. There is also an interesting experiment in the 1932 plantation at Chunabhati ; *mallata* (*Macaranga denticulata*) was sown

in lines and has germinated extremely well. This is the first record of this species having been raised artificially, although frequent attempts have been made, both in divisions and in the silvicultural garden at Sukna, without success.

(*c*) *Michelia champaca.*—A plot was laid out to discover if it is possible to raise this species by direct sowing, and to compare the results with 8 months old nursery transplants.

Sub-plots were raised with 8 months old transplants, by direct sowing as soon as the seed was ripe in August, and by the planting of seedlings at the time of pricking out in October. Transplanting of 8 months old plants gave cent per cent success. Direct sowing gave 7·8 per cent germination and 5·7 per cent survived at the end of the year. Pricked-out seedlings gave 15·5 per cent success at the end of the first month and 13·7 per cent survived at the end of the year. The casualties both with direct sowing and pricked-out seedlings appeared to be due to drought at the end of the rains. The experiment will be repeated this year using *boga medeloa* as a shade crop. It will be sown in June round each *thali* and should be tall enough to afford shade to the young *champ* during the cold and hot weather and so prevent casualties due to drought.

(*d*) *Sal plantations.*—*Thatch* grass often comes up as a heavy undergrowth in *sal* plantations and although the area is fully stocked with young seedlings, the rate of growth of the *sal* is slow. In fact in areas where the *thatch* grass is particularly dense the *sal* remains in a whippy stage. A plot has been laid out in such an area in the 1927 *sal* plantation at Moraghat, in the Jalpaiguri division, to see if by burning the *thatch* and coppicing the seedlings, and doing rains-weeding for one year, it will be possible to get the *sal* up above the level of the *thatch* grass.

(*e*) *Cover crops.*—The following species were experimented with as cover crops in *sal* plantations:—*Cassia tora, Clerodendron infortunatum, Leucaena glauca,* and Napier grass. These were shown in between the lines of *sal* with the object of suppressing and keeping down weeds and climbers, and so reducing the cost of weeding and cleaning. Results with *Cassia tora* and Napier grass appear decidedly promising. The experiments with *Cassia tora* were carried out by Mr. D. A. G. Davidson, Divisional Forest Officer, Kurseong division, and the remainder by the Silvicultural branch.

An experiment was carried out to see if the seed of *boga medeloa* (*Tephrosia candida*) that had been stored for one, two, and three years had retained its germinating power. Plots were sown up with seed of different years, and it was found that the germination per cent and subsequent rate of growth were equally good in all plots.

(6) *Reclamation and Afforestation.*

Nil.

(7) *Thinning and Cleaning.*

(*a*) The following order by Conservator of Forests, Northern circle, regarding thinning of *sal* plantations, may be of interest.

'After 6 growing seasons the trees of the future should have declared themselves. In the following cold weather a light crown thinning on the following lines is ordered :—

1. Removal of *kukat.*
2. Removal of wolf-trees.
3. Light thinning in the dominant class for the benefit of the trees of the future. (The dominated class will not be disturbed.)

By wolf-trees is meant badly shaped unsound or forked dominant trees and coppice stems occupying an abnormal amount of space.

Light thinning in the dominant class necessitates the selection of the trees of the future and removing other dominants interfering with them. In practice this operation will ordinarily involve the removal of very few stems.

The removal of suppressed stems is left to the discretion of the Divisional Forest Officer if he considers that it will decrease the cost of climber-cutting.

The next thinning will be made after the 11th growing season.

In plantations successfully burnt for 3 years a change to a drier type of undergrowth is expected. In this event it may be advisable to give more light on the ground by the removal of a part of the dominated class in addition to the 2nd light crown thinning among the dominants.'

(*b*) Sets of three plots each to study the effects of different grades of thinnings were laid out in *sal*, *dhupi* (*Cryptomeria japonica*), *panisaj* (*Terminalia myriocarpa*). Observations and measurements of these plots will be carried out at intervals of 5 years, and the comparative results, regarding rate of growth and volume increment per acre, will be noted.

(*c*) Extensive experiments were carried out by the Silvicultural branch and by the Divisional Forest Officers, Jalpaiguri and Kurseong divisions, to discover the best method of eradicating climbers in plantations. So far complete digging up and removal of the roots and tubers of the climbers from the area at the time of the formation of the plantation appears to be the best method. Although an expensive opera-

tion, results so far point to the fact that future expenditure on climber-cutting will be considerably reduced, and so money will be saved in the long run. Further detailed experiments will be carried out this year.

(*d*) *Experiments in controlled burning in* sal *plantations.*—These plots were started 3 to 4 years ago and already in the burnt plots the evergreen undergrowth is turning to a drier type, climbers are considerably less, and the general appearance of the burnt plots is more healthy. It was noticed that in plots where a heavy thinning had been done and where suppressed stems had been removed, that the change to a drier type was taking place much more quickly.

(8) *Mixtures in Plantations.*

(*a*) *Experiments in mixtures in Northern Bengal.*—At a Divisional Forest Officers' Conference held in October 1932, it was decided to experiment with mixtures on a fairly large scale, on the lines of the present European practice as indicated by the Central Silviculturist. Centres for experiments were selected in each of the divisions in Northern Bengal, which comprise plains, foot-hills, and hill forests. At each centre the following types of mixtures are being tried.

Mixed line sowings of two or more species ; alternate plants of two species and alternating plants of several species ; alternate lines of two species and alternating lines of several speci s ; alternating groups of lines (strips) of several species ; alternate plots of several species—individual plots being 36′×36′ ; matrix of shade-bearers with groups of light demanders.

(*b*) *Experiments in mixtures in Southern Bengal.*—Mr. N. Pal, Divisional Forest Officer, Chittagong Hill Tracts division, has, during the past two years, carried out experiments with mixtures of *gamari* (*Gmelina arborea*) in alternate lines with shade-bearers or semi-shade-bearers such as *mahogany* (*Swietenia macrophylla*), *gurjan* (*Dipterocarpus turbinatus*) and (*D. pilosus*) and *tali* (*Amoora*), not as permanent mixtures but with the object of affording shade to the shade-bearers, during the first few hot weathers and so to prevent casualties due to drought. Also it is hoped that the *gamari* will help to keep down weeds. The *gamari* will be removed as soon as it interferes with the growth of the shade-bearers. In 1931 the *gamari* was put out in lines 8′ apart and the mahogany and *gurjan* sown midway between the lines. This spacing was found to be too close and by November 1932 the *gamari* had already closed up and the other plants were badly suppressed. In the 1932 plantation the *gamari* was put out 6′×6′ in alternate lines to compare results of the spacing with that of 1931.

A small scale experiment was also carried out with a mixture of teak (*Tectona grandis*) and *jam* (*Eugenia jambolana*) both by quincunx planting with *jam* in the centre, and also in alternate lines. It is hoped

that the *jam* being a slower grower will eventually form a lower storey under the teak.

The Silviculturist has also drawn up a scheme for experiments with permanent mixtures on the lines mentioned for Northern Bengal. These will be carried out in the 1933 plantations in the Chittagong Hill Tracts division.

(9) *Underplanting.*

In the Chittagong and Chittagong Hill Tracts divisions plots have been under observation for the past 5 years in order to find out suitable species for under-planting or sowing under established *gamari* and teak plantations. In most plots underplanting was done after the first thinning in the 5th year, and in one or two planting was done in the second and third year after formation, just before the canopy had been completely formed. The results on the whole have been poor, and the few successful plots show that although it is possible to underplant successfully small areas with certain species the cost of establishing (weeding, etc.), the under-crop is very considerable, and would not be financially possible on a large scale. These underplanting experiments have therefore now been discontinued except for the few successful plots which will be kept on as a matter of interest. These plots have at least shown the most suitable species for underplanting, and by that indicated what species could be grown in mixtures. The most successful species were found to be *Swietenia macrophylla, Bambusa tulda, Dipterocarpus turbinatus, Artocarpus chaplasha,* and *Dichopsis polyantha.* If an understorey is required the only solution would appear to be mixtures at the time of planting. Experiments on these lines are now being taken up.

In Northern Bengal *champ* (*Michelia champaca*) appears to be doing quite well as an underplant to *Chickrassia tabularis. Sal* as an underplant to the same species has been a failure and has remained in a whippy and suppressed condition for several years.

(11) *Miscellaneous.*

(*a*) *Co-operative investigation on the origin of teak seed.*—Plots were started at Kaptai in the Chittagong Hill Tracts division in 1931 plantation, but with the exception of seed from Nilambur, Kaptai, and Tharrawaddy, results were extremely poor. Accordingly in 1932 fresh seed was indented for, and the blanks were filled up by direct sowing and transplanting. The undergrowth which came up consisted of patches of heavy *thatch* grass and Assam *lota* (*Eupatorium odoratum*) and made it impossible to fill up the gaps successfully, so when the plots were inspected in the cold weather of 1932, it was decided to repeat the experiments again in the 1933 plantation. Weeds, consisting mainly of

Assam *lota*, are so heavy in these areas that unless a complete stocking can be obtained in the first year, it is practically impossible to raise a successful plantation.

(*b*) Plots were laid out at Kaptai in the Chittagong Hill Tracts division to observe the relative incidence of rot in root and shoot cuttings of teak. Three plots were laid out (i) raised by direct sowing, (ii) by transplanting, (iii) by root and shoot cuttings. Plants from each plot will be sent each year to the Forest Research Institute for examination.

(*c*) In 1931-32, Mr. Ahmed, the Divisional Forest Officer, Cox's Bazar division, started a series of plots to find out the best rotation and method of treatment of *Melocanna bambusoides* and *Bambusa tulda* in relation to the existing system of cuttings by purchasers. These plots were handed over to the Silviculturist in 1932-33, and on inspection last cold weather it was decided that the plots laid out would not fulfil completely the objects laid down. Consequently 4 more sub-plots were laid out during the year.

(*d*) In Southern Bengal two plots were laid out—one of 50 acres in the evergreen forests at Mainimukh, Chittagong Hill Tracts division, and another of 20 acres at Medakachhapia in the deciduous dipterocarp forests of Cox's Bazar division. These are the first of a series of plots that it had been decided to lay out for the purpose of reserving in their natural state, areas of typical forest types, in accordance with Resolution No. 22 of the 3rd Silvicultural Conference held in 1929. In Northern Bengal such plots are now in the process of being laid out. When all have been completed, there will be approximately 25 such plots, comprising all the principal types in the province.

(*e*) *Loranthus attack in gamari plantations.*—Since the attack was first noticed in November 1931, all attacked trees have been cut down and the affected parts burnt. During the past year the attack has been comparatively slight and only a few further trees in plantations have been affected.

(*f*) *Urostylis punctigera.*—This pest continued to do a considerable amount of damage in *champ* plantations during the year under report. The Divisional Forest Officer, Jalpaiguri division, reports that the pest was not so severe during the past year owing to drought in the early part of the year, due to the late break of the rains, but this year rains were early and severe attacks have already been noticed in April-May.

II.—Working Plans and Statistics.

(1) *Working Plans.*

(*a*) The revised working plan for the Kurseong division was sent to press during the year.

(*b*) *Control Forms.*—Control forms Nos. 2 and 4 of all divisions were checked by the Silviculturist. This takes a considerable amount of his time which could be well employed on other work. It is hoped that a Working Plan Officer will be appointed in the near future, and that the checking of control forms will be handed over to him.

(2) *Yield Tables.*

(*a*) *Sample Plots.*—20 new plots were laid out during the year, and 38 were remeasured. There are altogether 189 permanent sample plots maintained in the province.

Diameter Increment Plots.—2 new plots were laid out and 2 remeasured during the year; altogether 19 plots are maintained in the province. One temporary sample plot was laid out in *Alnus nepalensis* in the Darjeeling division. Besides the above, observations and measurements, etc., have been recorded in 93 experimental and garden plots.

(*b*) 2 new linear sample plots were laid out, one in the Sundarbans division and the other at Bhomariaghona, Cox's Bazar division. Altogether 17 linear sample plots have been laid out.

5 old linear sample plots were remeasured in the Jalpaiguri division. These plots were laid out in order to study rate of growth, percentage of species and mortality in the more important types found in the natural forest; all trees that had reached 4″ in diameter at 4′ 6″, since last remeasurement, were included and numbered and measured. In all types of forest it was found that the majority of trees which had come in since the last remeasurement were of the evergreen type, such as *Chisocheton paniculatus*, *Amoora rohituka*, *Amoora wallichii*, *Dysoxylum binectariferum*, *Mallotus philippinensis*. This is of course due to fire protection. Many previously unidentified trees in these lines were identified during the course of the year.

(*c*) *Ring Counting and Stem Analysis.*—Stem analysis of the following species, grown in high forest and apparently of dominant canopy, were carried out during the year. *Cryptomeria japonica* 2 trees, *Alnus nepalensis* 1, *Michelia excelsa* 3, *Bucklandia populnea* 1, *Gmelina arborea* 1, *Cedrela toona* 1, *Terminalia myriocarpa* 2, *Duabanga sonneratioides* 1, *Chickrassia tabularis* 1, *Michelia champaca* 1, and *Dipterocarpus costatus* 3.

After collecting the necessary data, curves showing height, diameter, and volume over age will be prepared and preserved for comparison with curves obtained from sample plots of these species in plantations and high forest.

III.—Miscellaneous.

Ledger filing of all matters of silvicultural interest in publications received was carried out. There are now 164 specific files and 92 general

ledger files maintained. Records of measurements of sample and diameter increment plots were sent to the Forest Research Institute for computation of volume figures, and all observations in experimental plots were recorded and tabulated. Many photographs of silvicultural importance were taken, or received both from individual forest officers and from the Forest Research Institute during the year. There are at present 280 photographs of silvicultural importance in the provincial collection. A new issue of " Nursery and Plantation Notes for Bengal, 1933 " was completed and sent to the press. This book gives notes on general nursery and plantation practice, and detailed notes for the artificial regeneration of 72 important species.

BIHAR AND ORISSA.

I.—Experimental Silviculture.

(1) *General.*

The office of the Forest Research Officer was held by Mr. B. P. Basu, Deputy Conservator of Forests, throughout the year, but he was mostly busy on the work of revision of the Kolhan working plan. The attached Forest Ranger, Babu Vidya Sagar Sharma, was wholly employed in research work.

The research work in this province is entirely confined to stage I (small scale silvicultural investigations) and is directly under the Forest Research Officer. One experiment was, however, started by the Divisional Forest Officer, Angul division, to see if creeper cutting and girdling miscellaneous species followed by burning will induce *sal* regeneration on hill slopes.

Generally speaking, there are no stage II (economical application of stage I investigation) in this province. The lack of stage II investigations under the Divisional Forest Officers is, however, being felt. During the year it was proposed to start large scale experiments to improve the quality and increase the output of *sabai* grass in Singhbhum.

A plot measuring 55 acres in the form of narrow strips 5 chains wide was laid out in the bamboo forests of Angul to test the effect of clear felling the clumps on the production and growth of new culms.

No new experiments were started during the year. The four experimental plots to study the effect on the subsequent growth of coppice shoots produced, of burning back *sal* coppice after felling and closure, were re-introduced at the instance of the Central Silviculturist. It is also proposed to start another set of experiments on the same lines for replication.

The total number of sanctioned silvicultural experiments in the province is 150.

The chief lines of research are :—

(i) Natural regeneration of *sal.*

(ii) Artificial regeneration in general (mostly teak).

(iii) Reclamation of waste lands in the protected and private forests (recently started).

A party of silviculturists, consisting of representatives from Madras and Central Provinces headed by the Central Silviculturist, Forest Research Institute, visited the Singhbhum and Puri forests to study the question of management of *sal* forests with special reference to the problem of *sal* regeneration. As the tour was a very short one, other *sal* forests of the province could not be included in their itinerary.

(2) *Natural Regeneration.*

Sal.—(*a*) *From seed.*—Generally speaking, the province does not suffer from lack of natural regeneration except in Angul and Puri divisions in the moist valley bottoms, and in large isolated grassy blanks in other divisions ; the problem of natural regeneration is of less importance than elsewhere. Numerous experiments were laid out in the Orissa divisions in 1924-25 but they have largely failed to give the results which they might have given owing to lack of initial comparability and faulty technique. Two new sets of experiments have recently been started in Saranda and Puri divisions to determine the effect of canopy density, fencing, soil working and burning where natural regeneration is deficient.

So far little or no attention was paid to test the effect of game proof fences in *sal* regeneration areas. It has, however, been noticed by the Angul Divisional Forest Officer that the growth of fenced *sal* plantation in Raigoda block is better than in a similar but unfenced plantation in Labangi block.

Sal.—(*b*) *From coppice.*—Coppice growth is generally satisfactory throughout the province and clear-felling has done extremely well. In Palamau, however, in the areas suffering from frost, the system of clear-felling may have to be modified. Without attempting to draw any final conclusion, it can be stated that in the two pairs of plots in the Sambalpur East division, burning appears to have caused a temporary set-back in the growth of *sal* coppice shoots which was made up after three seasons growth, after which there were indications of better growth from the burnt shoots. A further measurement of these plots would be interesting to test whether a significant lead is taken by the burnt plots.

Sal.—(*c*) *General.*—Other facts which can be treated as *ad interim* results from the *sal* regeneration experiments are :—

(i) Seedling regeneration is obtained under any canopy, except in extremely unfavourable localities where regeneration conditions are disturbed by such agencies as fire, grazing, man, etc., but the establishment of seedlings requires a somewhat open overhead canopy.

(ii) While this appears to be an established fact, *sal* is likely to be ousted by weeds and miscellaneous species by too much opening in the canopy except in extremely favourable localities with plenty of advance growth.

(iii) It appears that *sal* is likely to gain ground in mixed forests by the removal of miscellaneous species ahead of *sal*; burning of undergrowth preceding the main felling is also likely to cause increased recruitment of *sal* in the more evergreen type.

(iv) Natural regeneration does not appear to progress under a full canopy with fire protection, burning making but little difference to the undergrowth which is light and almost without grass.

(v) In the evergreen types successive burnings appear to have produced a seral retrogession with consequent change in the character of undergrowth from *Actinodaphne angustifolia* to *Imperata arundinacea* with an intermediate stage of *Macaranga peltata.*

Seedling regeneration is generally adequate in our high forest areas. While their establishment is accelerated in valleys and lower hill slopes by the removal of overhead canopy, in somewhat drier localities they appear to be doing well under a fairly dense canopy. This shows that the deficiency in soil moisture is made up by shade, or in other words the light requirements of *sal* vary inversely with the available soil moisture. It is, therefore, possible to obtain requisite moisture conditions for seedling regeneration and their establishment especially in dry areas by canopy manipulation; this aspect of the question has never been investigated. As a result of his tour, the Central Silviculturist has suggested certain experiments which includes this problem. These experiments will be started in the next few years.

Bamboos.—(*Dendrocalamus strictus.*)—To study the effect of fire on the reproduction of bamboos, experimental burning was carried out over an area of 400 acres in Angul; the fire was pretty severe and scorched some green culms at the periphery of the clumps. These scorched culms dried ultimately. The number of new shoots were very few in

1931, but very high in 1932. It is also noted that the quality of the shoots in the burnt area is better than otherwise. Two experimental plots were laid out by Messrs. Heilgers & Co., to test the effect of clear-felling half the clump on the reproduction and growth of culms. The number of new shoots in the cut and uncut halves were as follows upto 1932 :—

Plot.	1929.		1930.		1931.		1932.		Total upto date.	
	Cut.	Uncut.	Cut.	Uncut.	Cut.	Uncut.	Cut.	Uncut.	Cut.	Uncut.
Chhota-Mu n d a Plot.	92	286	137	313	50	63	24	127	303	789
Tainsi Plot .	243	446	333	601	52	167	127	109	752	1,823

It can, therefore, be concluded that uncut halves produced more shoots than the cut halves. The experimental plots under the Research division have not been in existence long enough to give any definite results but should they prove the same thing it may be necessary to change the present system of working by Messrs. Heilgers & Co.

(4) *Nursery Experiments.*

Two Grunwald's apparatus for testing the germination percentage of seeds were purchased during the year. The seeds collected from various divisions will, as a matter of routine, be tested before they are put out in the nursery.

Pinus longifolia.—Chakrata division seed gave a seedling percentage of 7 only.

Acacia arabica.—Seed obtained from Clutterbuckganj, United Provinces, and soaked in boiled water and kept under water for 7 days before putting out in the nursery gave a seedling percentage of 30 in sunken beds and 10 in raised beds.

Tectona grandis.—Local seed from Puri gave a seedling percentage of 11 against a seedling percentage of 6 for Burma seed. The seeds were soaked in cowdung and water for 72 hours before putting in the beds. In both the cases germination commenced between the second and third weeks. Seedling percentages under various treatment for seed of different origin have been omitted.

Pterocarpus marsupium.—Seed with the pod removed gave cent. per cent. germination.

One year old seeds, stored in closed tins, of the following species were sown in nurseries but they failed :—*Acacia catechu, Casuarina, Anogeissus latifolia, Dendrocalamus strictus, Schleichera trijuga.*

The nursery beds were manured at the rate of 9 tons of cowdung to the acre.

Himalayan Horsechestnut.—Seed obtained from the East Almora division were sown in the Neterhat nursery and gave about 90 per cent germination.

(5) *Artificial Regeneration.*

Artificial regeneration of teak and *Casuarina equisetifolia* is engaging our attention most for the present.

Tectona grandis.—Teak plantations in Puri and Angul were extended by 59 acres. The *taungya* system is again being introduced gradually but slowly. It is too early to say if this system will be popular. It is now an established fact that the best way of propagating teak is by root and shoot cuttings. Last year's experiment in the Hinoo nursery has shown that hot weather planting in April and May can be done with success. The same experiment shows that root and shoot cuttings of 2 to 3 years old plants will do better than transplanting one year seedlings. Root and shoot cuttings are being tried this year in some plantations and if it succeeds it will reduce the weeding costs greatly.

Pinus longifolia.—Small scale plantations of *Pinus longifolia* in the Neterhat plateau are doing exceedingly well; in some of the older plantations a certain amount of regeneration is coming up. It is now proposed to extend the plantation in this plateau as quickly a possible.

Of the other species tried in the same plateau, *Cedrela toona* and *Eucalyptus citriodora* are doing best.

Sabai grass.—The experiments in the Kolhan division have now definitely proved that it is possible to increase the output of *sabai* grass (*Pollinidium angustifolium*) to as much as 26 maunds per acre in plantations raised by planting root stocks. The most important and obvious curtural operation in such plantations is weeding. Burning, though very necessary, is a secondary requirement.

Dendrocalamus strictus.—Small scale experiments have proved that it is possible to propagate bamboos by culm planting (culms with rhizomes) but probably the best way of raising them would be by transplanting one year old seedlings, although the germination percentage from seed is fairly low.

(6) *Reclamation and Afforestation.*

Casuarina equisetifolia.—There was practically no new plantation work except two small patches of the newly acquired area, 1·75 acres. In addition, failures over an area of 99 acres in the old plantations of 1926, 1927 and 1931 were replaced by planting. Attempts are being made to introduce other miscellaneous species in the plantations and

Eucalyptus rostrata, Melaleuca leucadendron, Grevillea robusta, Careya arborea, Eugenia jambolana, Azadirachta indica, Albizzia lebbek were tried. Of these *Eucalyptus* is doing the best and *Albizzia* the worst. *Calophyllum inophyllum* plants planted in mixture in alternate lines with *Casuarina* are doing very well and they have fruited for the first time. On the other hand, pure plantations of *Calophyllum* have proved failures.

Small scale experiments indicate that eroded lands can be successfully planted up with *sabai* grass. It is also possible to afforest grassy blanks in forests with cuttings of *Dolichandrone platycalyx*; *Eugenia jambolana* has also proved a success in planting up these blanks while swampy areas can be re-habilitated with *Terminalia tomentosa* planted on mounds.

(11) *Miscellaneous.*

In the teak plantations a good deal of evergreen growth and bamboos are coming up spontaneously much to our relief.

Various caniferous seeds are being tried in the Neterhat plateau by the Divisional Forest Officer, Palamau division, and it is possible that in future the whole of the plateau (excluding cultivation) will be turned into a coniferous forest.

II.—Working Plans and Statistics.

(1) *Working Plans.*

The Angul and Puri plans were printed during the year and most important feature of these plans is reversion to the selection system. Adequate provision has been made to extend the teak plantation. *Casuarina* plantation will be worked for the first time under a regular scheme.

Sambalpur East and West plans are awaiting final approval of Government while Palamau and Kolhan plans are almost ready to be submitted to Government. In Sambalpur East the strip system has been abolished, while in Sambalpur West the old conversion working circle has been merged into the coppice working circle. In Palamau and Sambalpur West departmental early burning will be adopted under the prescriptions of the revised plans. The characteristic feature of the Kolhan plan is reversion to the selection system with volume control.

(2) *Yield Tables.*

Intermediate five yearly measurements were due in thirty-nine sample plots and they were re-measured.

During the year more coppice coupe outturn figures were collected in the Sambalpur West division.

(3) *Volume and Form Factor Tables.*

It is now proposed to collect volume outturn figures in the Angul division in the standard Forest Research Institute form.

III.—Miscellaneous.

Lantern lectures on the improvement and extension of the forests of Bihar and Orissa were delivered by the Private Estate Forest Officer and the Forest Research Officer in various centres. These lectures were highly appreciated by the public.

The Bihar and Orissa Forest Association started in 1931 is thriving. The Association has given a great impetus to the question of reservation and management of private forests by the Forest Department.

An attempt is being made to introduce bird life in the *Casuarina* plantation to mitigate the evil from insect pests. Partridge and jungle fowl were caught elsewhere and let loose in the plantation.

BOMBAY.

I.—Experimental Silviculture.

(1) *General.*

Under the direct control of the Chief Conservator's office there were 11 subjects under investigation during the year; one of these (No. 10—The Economic Age for Cutting *Populus euphratica*) has been completed, having yielded useful information of local importance.

The work done and conclusions arrived at are briefly described as follows :—

(2) *Natural Regeneration.*

Sandal (*Santalum album*).—After the research investigation in connection with subject No. 28—Effect of early burning on sandal growth and regeneration had concluded, the two plots maintained in the Belgaum division were subjected to a late fire on 30th March 1932, and it was made abundantly clear that such late fires are very destructive and must as far as possible be prevented in all sandal areas. Early burning tends to mitigate the severity of fires occurring late in the season, and a fire which breaks out in an area which has been protected from a succession of years, causes more damage than in areas burnt more frequently.

(5) *Artificial Regeneration.*

Rosha grass (*Cymbopogon martinii*).—*Subject No. 12.*—Artificial propagation of *rosha* grass (West Khandesh). Nursery experiments

having shown that a high percentage of success was attainable, it was decided to put the results obtained to a practical test and orders were issued to plant up about 7 acres of land situated on a permanent fire line with tussocks of the grass. Last year and the year before, for some reason or other, no work was done, but during 1932 an area approximately 7 acres in extent was ploughed and planted at a cost of Rs. 117. A cessation of rain caused many casualties and was responsible for large gaps in the crop. The whole crop together with other growth was cut back and burnt and after the *rosha* threw out fresh shoots a thorough examination of the area disclosed that about 50 per cent. success had been secured. *Rosha* requires, it is locally believed, three years to establish itself. The plantation thus started will be kept under observation for 3 years from now and supplemented each succeeding monsoon with fresh tussocks; revenue and expenditure will be recorded.

Propagation of hirda (*Terminalia chebula*).—*Subject No. 13.*—(Satara and Poona). Nurseries were maintained in the Satara and Poona divisions with the object of attempting the artificial propagation of *hirda* by means of "stump" planting with seedlings of known age. In the Poona division out of 1,200 plants raised in the nursery 605 were survived at the end of December. These are being watered and are reported to be healthy. In the Satara division the nursery was laid out in the Mahableshwar range and out of 900 plants raised 239 survived on 15th February 1933. Stump planting will be carried out during the ensuing rains.

Khair (*Acacia catechu*).—With a view to collecting confirmatory evidence of the possibility of artificially reproducing *khair* by means of root and shoot cuttings experiments were undertaken in the scrub jungles of the North, East and West Khandesh divisions. Nurseries have been established in the above divisions and the seedlings raised therein will be utilised for stump planting in the rains of 1934.

Miscellaneous.—An experiment aiming at the eradication of prickly-pear by means of the cochineal insect was tried in the Dharwar and Badami ranges. Cactus leaves covered with the insects supplied by the Assistant Professor of Entomology, Poona, were tied to the leaves of prickly-pear bushes, once in the summer and again in the rains. On both occasion the insects did not survive, due it is surmised, to adverse climatic conditions in the summer and heavy rains during the monsoon.

(7) *Thinnings and Cleanings.*

Teak.—Subject No. 4.—Effect of thinning teak coppice at different ages (East Thana). Remeasurements taken of the coppice in four out of the eight plots under observation have at this stage yielded figures which show that the girth development in the thinned areas as a whole

is greater than in the unthinned plots. The numbers on all trees in the unthinned plots were renewed and the boundary posts repainted where necessary, while missing trees have been marked with a red circle on the tree charts and necessary entries made in the lists. It has been decided that height should be measured at intervals of 10 years instead of 2 years as originally intended.

Sandal.—Subject No. 7.—Annual girth increment of sandal (Belgaum and Dharwar-Bijapur). The second re-measurements of the trees in the two plots in the Dharwar-Bijapur division were recorded in November 1932. No deductions are possible at this stage.

Babul (Acacia arabica).—Subject No. 8.—Increment of *babul* under different degrees of thinning (Hyderabad, Sind). During the year such computation work as was possible with the data recorded was accomplished. Advantage is being taken of the Central Silviculturist's offer to assist with all necessary computations. The records are being sent to the Forest Research Institute and future work will be based on the instructions and advice of the Silviculturist.

Bahan (Populus euphratica).—Subject No. 10.—The economic age for cutting *bahan* (Shikarpur). This experiment is now complete. From the careful analysis of the results prepared by the Divisional Forest Officer it is established that when allowance has been made for differences in soil, degree of inundation and variation of market rates and demand, the economic age for cutting *bahan* coppice in Upper Sind is approximately six years.

II.—Working Plans and Statistics.

The following working plans were sanctioned during the year :—

(1) Working Plan for the Sandal Forests of the Dharwar-Bijapur division and of Haliyal and Mundgod ranges of Northern and Eastern Kanara divisions, respectively.

(2) Working Plan for Soppin-hesalli High Forest (Block XXVII) in Kanara Southern division (Revised).

(3) Thana Malki Teak Working Plan.

BURMA.

I.—Experimental Silviculture.

(1) *General.*

Mr. W. S. Shepherd, Deputy Conservator of Forests, was in charge of the division until the 20th May, Mr. G. S. Shirley, Deputy Conservator

of Forests, until the 14th November and Mr. R. W. V. Palmer, Deputy Conservator of Forests, from that date until the end of the year. The programme of work was carried out in full together with the arrears in Tharrawaddy and Zigon divisions from the year before. While in the Tharrawaddy district, the statistical party was armed by the District Magistrate as a precaution against interference.

(2) *Natural Regeneration.*

Regeneration of In (*Dipterocarpus tuberculatus*).—*Projects E. 1* (*a*) *to* (*d*).*—Experiments are mainly in the Yinke reserve, Katha forest division, where the special problem is the invasion of *thetke* and *mwe* grasses (*Imperata* spp.) when the canopy is opened. Certain evidence available from the plots formed in the last 10 years is collected below.

Eight plots number 12-19 each measuring 0·4 acre were laid out in compartment 53 in February 1925 and the overwood marked for extraction. The lessees failed to remove the overwood, and apart from the girdling of the teak in one plot in 1925 and a little felling in one other plot in the same year, nothing has been done at all except periodic countings of regeneration on the ground involving trampling of the grass, etc. In each one of the eight plots there is a definite increase in the total number of seedlings up to December 1931 when the last count was made, and no increase in the number of seedlings 5′ and over. The plots are not fire-protected.

In 1926 and 1928 six one-acre plots were laid out in compartment 36 and compartment 44 to study the inducement of regeneration of *in* in advance of felling; all plots lie in pure *in* high forests. The overwood is very complete in plots 20, 21 and 24 in which there is little grass, and more open (and more mature) in plots 22, 23, and 25 where there is more grass. In plots 21 and 23 hoeing was done in 1926 but nothing else has been done beyond periodic counting. The plots are not fire protected. There are occasional set-backs but on the whole all plots show marked increase in numbers, but as in the other plots there is no increase in the number of seedlings over 5′ high. While there is no proof that similar increases have not been going on without assistance throughout the reserve it seems hardly likely. It looks as if the increases were at any rate partly due to the trampling down of the grass by the counting party. If so there should be no great difficulty in obtaining an increase of regeneration by suitable treatment during the period preceding the final removal of the crop. The figures also show that good seed years are only occasional. The years 1929 and 1932 were

*Note.—In the following report the letters 'E' and 'S' followed by Roman numerals refer to the project numbers of the research programme published on pages 63 to 66 and 73 of the Annual Report on the Working Plans and Silviculture in Burma 1926-27. The letter 'E' denotes Experimental Plots and the letter 'S' Statistical or Sample Plots.

markedly good and this was observed to be so both for *in* and for *ingyin* elsewhere in the Yinke and also in the Shwegu reserves.

Casualties in regeneration once got on the ground have to be reckoned with, but are nowhere very high. There is no tendency for the regeneration obtained to grow up, presumably because the canopy remains closed. There is ample evidence to show that for *in* (and for *ingyin*, *Pentacme suavis*) protection from fire is fatal to the inducement of regeneration.

As regards the use or exclusion of fire and its effect on the establishment of *in*, experimental plot 6 is interesting as it is the only clear-felling experimental plot in the reserve. There is no possibility here of new regeneration coming in. This plot of 10 acres was formed in 1923. The area was divided into 2 halves and one was protected from fire and the other burnt annually. In the middle of each a half-acre counting plot was laid out. Protection was successful except in 1928. It should be noted that the burnt plot is deliberately burnt each year when the fire lines are cleared. The natural forest on the other hand often escapes burning altogether. The comparison is therefore between fire protection and annual burning and not between fire protection and natural conditions. This plot is referred to in page 35 of the Annual Report for 1931-32.

Height classes in feet.	November 1924.	November 1925.	February 1928.	March 1929.	January 1930.	November 1930.	December 1931.	January 1933.
			PROTECTED PLOT No. 6 A.					
0′ to 5′ . .	1,477	1,241	882	1,168	1,420	1,226	1,097	1,120
5′ to 10′ . .	697	583	261	134	128	80	94	77
10′ and over .	80	345	739 } 1,000	763 } 897	757 } 885	780 } 860	712 } 806	721 } 798
TOTAL (1 ACRE)	2,254	2,169	1,882	2,065	2,305	2,086	1,903	1,918
			BURNT PLOT No. 6 B.					
0′ to 5′ . .	1,061	930	861	862	993	997	805	834
5′ to 10′ . .	201	155	194	167	90	68	101	88
10′ and over .	42	91	201 } 395	265 } 432	337 } 427	351 } 419	353 } 454	364 } 452
TOTAL (1 ACRE)	1,304	1,176	1,256	1,294	1,420	1,416	1,259	1,286

The figures suggest among other things that :—

(*a*) The original stocking was insufficient. Probably 4,000 seedlings per acre or more are required.

(*b*) The casualties in 10 years are small, probably less in either plot than might be expected from overcrowding had regeneration been dense throughout at the beginning.

(*c*) In the protected plot there has been no progress towards establishment of a crop (*i.e.*, no increase in the total number of trees 5′ and over) since 1928. In the burnt plot similar progress towards establishment has been very slow since 1929.

(*d*) Actually inspection shows that both plots contain in the south some dense groups of sapling regeneration which must have been well established 4 years ago (see the number of trees 10′ and over in each plot in February 1928).

It might be said that the fire of 1928 prevented establishment in the protected plot. It certainly did and allowance must also be made for decreases in the 5′ and over class in the well established parts owing to deaths from overcrowding but the same state of equilibrium between *in* regeneration and competing woody growth and grass 2 to 4 years after opening the canopy is observable elsewhere—for instance in the six plots below.

These are the strip felling plots No. 7 A-C referred to on page 36 of last year's report. The figures have been lumped together and are given below. There has been no accidental fire in the protected plots which have been protected since 1924. The overwood was felled in strips of various widths in 1923.

Height classes in feet.	November 1924.	November 1925.	February 1928.	March 1929.	January 1930.	November 1930.	December 1931.	January 1933.
	BURNT PLOTS No. 7 A, B & C, TOTAL AREA 1·2 ACRES.							
0′ to 5′	1,364	1,400	1,080	1,314	1,724	1,884	1,837	1,712
5′ and over	114	143	242	200	175	188	202	183
TOTAL	1,478	1,543	1,322	1,514	1,899	2,072	2,039	1,895
Average per acre	1,232	1,286	1,102	1,262	1,582	1,727	1,699	1,579
	PROTECTED PLOTS No. 7 A, B & C, TOTAL AREA 1·2 ACRES.							
0′ to 5′	1,017	715	561	640	674	682	620	577
5′ and over	169	224	288	283	279	299	294	290
TOTAL	1,186	939	849	923	953	981	914	867
Average per acre	988	782	708	769	794	818	762	723

Inspection in 1933 of all these plots shows that the object, *i.e.*, the establishment of a crop, has failed both under fire protection and under annual burning. Stocking being insufficient we were dealing mostly with individual seedlings of *in* and not with dense masses which is the natural means adopted by this species to regenerate itself. The experiments show how difficult it is to nurse individual seedlings of *in* against all competitors. They are scorched back by these competitors where fire enters and smothered by them where it does not. Practical stag-

nation sets in in either case which could presumably only be relieved by expensive cleanings. Where sufficiently dense on the ground, *e.g.*, in parts of Experimental Plot 6, the crop was established 4 years after clear-felling whether burnt or not.

The above appears to emphasise the importance of getting complete regeneration on the ground before final felling and suggests that time and care is likely to be spent more profitably in assistance to the future crop before this operation than after it.

(3) *Seed.*

(i) *Investigation of the influence of seed origin in the case of teak.*— These experiments, which are being carried out in collaboration with the Central Silviculturist, were referred to in the Annual Report for 1931-32 at page 39.

A fresh set of experiments was put down in Upper Burma at Pinbaw in Myitkyina division in May 1932 but no fresh set was put down in Lower Burma owing to disturbed conditions. In 1933 experiments will be repeated both at Pinbaw in Myitkyina division and at Kunsan in Zigon division.

The survivals of the line plantings of the 1931 rains in Zigon division (Experimental Plot No. 7) were remeasured in January 1933 after two seasons growth with the following results :—

Origin of seed.	No. of plants.		No. of blanks.	Percentage success.	Average height (feet).
	1st July 1931.	27th January 1933.			
Nilambur	100	91	9	91	10·1
Travancore	100	90	10	90	9·2
Zigon	100	85	15	85	8·8
Kanara	100	80	20	80	9·0
Khandesh	100	82	18	82	6·5
Myitkyina	100	81	19	81	8·7

The survivals from the seed sown at stake in Zigon division in the rains of 1931 (Experimental Plot No. 8) were also measured in January 1933 after two seasons growth with the following results :—

Origin of seed.	No. of seedlings.		No. of blanks.	Percentage success.	Average height (feet).
	1st July 1931.	28th January 1933.			
Nilambur	400	379	21	95	7·9
Travancore	220	181	39	82	7·1
Zigon	400	361	39	90	6·4
Kanara	320	294	26	92	6·8
Myitkyina	272	262	10	96	6·7

Re-measurement figures for the 1931 experiment in the Myitkyina division are not at the moment available but the results to date of the 1932 experiment in the Myitkyina division are as below. This is Experimental Plot No. 13. Seed of 6 different origins was used. All seed was reported as collected in 1932. There were considerable differences in the size and weight of the various seeds. Approximately the following numbers of seeds were found to go to the pound weight:—

Nilambar	462
Travancore	829
Khandesh	828
Kanara	1,330
Tharrawaddy	418
Myitkyina	656

Seed was sown in nurseries and transplanted later to stake. Half the seed was soaked for 48 hours before sowing and half was sown untreated.

Germination figures are given below :—

Origin.	Treatment.	Seed sown.	Date of sowing.	First germination.	No. of seeds germinated.		Percentage germination to 30th June 1932.
					31st May 1932.	30th June 1932	
Nilambur	Unsoaked	686	6th May 1932.	1st June 1932.	0	218	32
Nilambur	Soaked	700	7th May 1932.	31st May 1932.	2	234	33
Travancore	Unsoaked	3,000	6th May 1932.	30th May 1932.	3	621	21
Travancore	Soaked	3,000	7th May 1932.	28th May 1932.	15	729	24
Khandesh	Unsoaked	3,000	6th May 1932.	31st May 1932.	1	81	3
Khandesh	Soaked	3,000	7th May 1932.	29th May 1932.	4	186	6
Kanara	Unsoaked	3,000	6th May 1932.	31st May 1932.	1	18	0·6
Kanara	Soaked	3,000	7th May 1932.	2nd June 1932.	..	206	7
Tharrawaddy	Unsoaked	3,900	17th May 1932.	31st May 1932.	2	584	19
Tharrawaddy	Soaked	3,000	19th May 1932.	29th May 1932.	12	792	26
Myitkyina	Unsoaked	3,000	6th May 1932.	30th May 1932.	3	188	6
Myitkyina	Soaked	3,000	7th May 1932.	31st May 1932.	1	203	7

Germination continued during July but the increases were small. On July 31st the highest germination was 37 per cent. (Nilambur soaked seed).

Transplanting to stake was done as soon as sufficient seedlings were available to plant up one row. There were 40 plants to each row and each row was formed of 20 seedlings from soaked seed and 20 from unsoaked seed. There were 5 rows for seed of each origin arranged in the order shown in the table. Thus Nilambur seedlings were planted in rows 1, 7, 13, 19, 25 and Travancore seedlings in rows 2, 8, 14, 20 and 26 and so on. Two hundred seedlings of each origin were planted and a summary of the results is given below. It is curious that the height growth of the Travancore and the Myitkyina plants does not seem to be affected by differences in the date of germination and transplanting.

Origin of seed	No. of plants.		Survival per cent.	Height class on 10th December 1932.						Per centage of plants.	
	Originally planted.	10th Dec. 1932.		Under 6".	6" to 11".	1' 0" to 1' 5".	1' 6" to 1' 11".	2' 0" to 2' 5".	2' 6" to 2' 11".	3' 0" and over.	2' 0" and over.	3' 0" and over.
						Summary.						
Nilambur .	199	188	94	..	18	49	49	31	20	21	38	11
Travancore.	200	193	96	..	2	31	43	37	34	46	61	24
Khandesh .	200	179	90	20	76	28	16	12	11	16	22	9
Kanara .	200	186	93	2	66	75	25	7	5	6	10	3
Tharrawaddy	200	191	95	..	7	59	45	26	32	22	42	1
Myitkyina .	199	188	94	..	8	35	60	38	26	21	45	11

(ii) *Germination test with Xylia dolabriformis stored seed—E. X. c and d.*—A test of *pyingado* seed collection in the Okkan range, Insein division, in 1932 was made during May 1933. The seed, which had not been exposed to damp from the time collected was put out in the sun to remove any possible moisture and packed and sealed in dry clean kerosine oil tins without either charcoal or naphthalene at the beginning of May 1932. The sealed tins were stored in the office in Insein.

One tin was opened in May 1933 and after rejecting a small quantity (estimated at 6 per cent.) as obviously unsound, 1,000 seeds were sown in a nursery bed on the 10th May at Sinte-sakan in Insein and watered daily. Germination started on the 14th May and by the 23rd May 74 per cent. had germinated as against 55 per cent. in the control bed of 1933 seed (200 seeds). By 28th May 927 out of 1,000 of the 1932 seeds had germinated and 186 out of 200 of the 1933 seeds. Percentage germination in both cases was 93 per cent. The rains broke about the 23rd May and rainfall was practically continuous between the 24th and 27th May. These extremely wet conditions appeared to be more favourable to germination than the alternation of hot sun and watering which preceded them.

II.—Working Plans and Statistics.

(1) *Working Plans.*

Field work and Area.—Owing to financial stringency, all working plans field work has been temporarily postponed. This is regrettable as not only does it entail arrears in the preparation of working plans, but also the disorganization of the highly trained working plans parties, but the postponement is unfortunately unavoidable in view of the state of the provincial revenues.

Compilation.—During the year under report new plans for an area of 1,729 square miles were sanctioned as against new plans for 2,030 square miles and revised plans for 1,555 square miles in the preceding year.

The position as regards working plans at the close of the year under report as compared with that at the close of 1920-21, when the Working Plans Circle was formed, is shown below. For the purpose of comparison the figures for the Federated Shan States are included :—

	1920-21.	1932-33.
	Sq. miles.	Sq. miles.
Area under sanctioned working plans	10,855	24,972
Area for which plans are under preparation	328	931
Area for which plans are required	8,236	1,326
Total	19,419	27,229

The following shows approximately the work done or in hand at the close of the year since the formation of the Working Plans Circle in 1920-21.

*Plans based mainly on field work.**

	Sq. miles.
Original	8,523
Revision	5,814

"*Paper*" *Plans.*

Original	7,045
Revision	4,710
Total	26,092

(2) *Yield Tables.*

S. VI.†—Further figures are being collected for outturn volume tables for teak from various types of forest.

* This also includes areas for which detailed enumeration is unnecessary and was not carried out.

† Roman numerals refer to project numbers of the Burma Research Programme.

The following new sample plots were formed during the year :—

	Plots.
S. II.—Volume increment per acre. Teak	5
S. III.—Volume increment per acre. Other species . . .	11
S. IV.—Girth increment of individual trees other than teak .	2
TOTAL .	18

The following sample plots were remeasured during the year :—

	Plots.
S. II.—Volume increment per acre. Teak	30
S. III.—Volume increment per acre. Other species . . .	12
S. IV.—Girth increment of individual trees other than teak .	28
TOTAL .	70

S. V.—Some data were collected for *ingyin* (*Pentacme suavis*) and *in* (*Dipterocarpus tuberculatus*) and the results obtained have been worked out and are given below. Figures for *ingyin* were obtained from about 150 trees measured in the Yinke reserve, Katha division, during the course of extraction in the hot weather of 1932. Measurements had necessarily to be made quickly to avoid delaying extraction. The table gives approximate figures based on diameter over bark at breast height, total height, and age from ring counting of fresh stumps. Counting of rings was difficult and the variations in age admittedly considerable.

Pentacme suavis. Age—Diameter—Height.

Diameter class (inches).	No. of trees.	DIAMETERS (INCHES).			HEIGHTS (FEET).			APPROXIMATE AGE (YEARS).		
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
8—12 .	39	11·7	8·0	10·0	84	51	69	68	40	56 (20 trees only).
12—16 .	55	15·9	12·0	13·9	97	60	81	129	50	85 (50 trees only).
16—20 .	42	19·9	16·0	17·7	105	65	90	143	68	104 (38 trees only).
8—20 .	136	19·9	8·0	13·9	105	51	81	143	40	87 (108 trees only).
20 and over	10	28·4	20·2	22·3	108	86	103	188	68	135 (9 trees only).

To obtain taper figures, the diameters under bark at 5′ 0″ and at various other heights above ground were taken. The latter were deducted from the diameter at 5′ 0″ and the differences averaged for each height by 4″ diameter classes. From these a curve was plotted for each diameter class and a table prepared.

Figures for *in* (*Dipterocarpus tuberculatus*) were obtained from 26 trees measured in the Yinke reserve, Katha division, and 4 measured

in North Toungoo division, and were worked out in the same way as for *ingyin.*

S. V.—Shrinkage figures after girdling for the girth at 4′ 10″ of 130 trees in the Prome plantation of 1858 were collected in last year, but no further measurements were made this year over bark as the bark had disappeared in most cases. The 130 trees were re-measured under bark with a steel tape at 4′ 10″ and the figures below show the progressive timber shrinkage since girdling :—

Girth class.	No. of trees.	Average girth shrinkage in inches under bark.	
		One year after girdling.	Two years after girdling.
3′ to 3′ 6″	21	·13	·23
3′ 6″ to 4′	21	·13	·24
4′ to 4′ 6″	22	·17	·26
4′ 6″ to 5′	22	·13	·28
5′ to 5′ 6″	19	·18	·30
5′ 6″ to 6′	15	·18	·33
6′ to 6′ 6″	10	·25	·38

CENTRAL PROVINCES AND BERAR.

I.—Experimental Silviculture.

(1) *General.*

Owing to changes of the silviculturist and of his headquarters, experimental work has been carried out under difficulties.

In all there were 27 experimental plots on the provincial list at the end of the year. One plot, namely No. 1 permanent at Betul, was transferred to the list of tree increment plots, while a new plot was laid out in South Chanda in March 1933 to study the effect of *Petalidium barlerioides* on teak regeneration. The territorial distribution of the plots is given below :—

Eastern Circle	1
Central Circle	16
Western Circle	10
	27

Distribution by species is as follows :—

Teak (*Tectona grandis*)	16
Sal (*Shorea robusta*)	1
Rohan (*Soymida febrifuga*)	3
Miscellaneous species	6
Bija (*Pterocarpus marsupium*)	1
	27

The silviculturist visited many of the plots during the year.

A number of interesting local experiments in natural regeneration were carried out during the year by divisional forest officers. Though the results are likely to be useful, they would be much more so if the experiments were carried out on more standardised lines. During the coming year the standardisation of these divisional experiments will receive the attention of the Silviculturist. The most important of these experiments were the laying out of plots in Mandla and Balaghat in order to study the effect of various factors in *sal* regeneration and to eliminate invasive *karka* (*Bridelia retusa*) which presents a difficult problem in regeneration. Other local experimental plots were laid out in Yeotmal, South Chanda, Nagpur-Wardha and Nimar.

(2) *Natural Regeneration.*

(i) *Tectona grandis* (*teak*).—(*a*) *Seedling regeneration.*—It is now generally agreed that the chief factors necessary for obtaining good teak regeneration are a fairly dense overhead canopy, absence of grass and a deep, damp soil. Conditions favourable to regeneration are thus present if fellings have not been so heavy as unduly to open the canopy. Moderate grazing and an underwood of bamboos assist in the process by restricting the rank growth of grass which makes the establishment of teak regeneration impossible.

In many divisional reports, the abundance of teak regeneration is emphasized in forests which are moderately heavily grazed, and in bamboo forests. When conversion fellings are carried out in teak forests with bamboos, clear fellings of the overwood and of the bamboos are usually silviculturally necessary. The Betul report advocates that the bamboos should be clear felled two years in advance of the main felling ; in Hoshangabad and elsewhere, it is now the practice to sell the bamboos at cheap rates one year in advance, in order to encourage their removal and to reduce the cost of departmental fellings.

Several officers have remarked on the spread of teak regeneration in mixed forests wherever the canopy is sufficiently dense to eliminate heavy grass. When clear fellings are made in such areas, the type of forest often changes in a few years from mixed forest with an under-

wood of teak regeneration to a young forest of pure teak. In Raipur it is observed that teak regeneration appears much better able to establish itself in mixed forest than in pure teak forest.

The shelterwood system, uniform system and regeneration fellings are now generally recognised as unsuited for silvicultural conditions obtaining in the teak forests of the Central Provinces. It is essentially in Periodic Block II that we have to seek to obtain regeneration many years in advance, mainly by keeping the canopy closed and by the admission of moderate grazing. Periodic Block I is merely the area in which adequate regeneration has already been obtained at some past period and in which the conversion process is being completed by the simple process of more or less clear felling the overwood.

In most divisions, the presence of adequate teak advance growth has resulted in satisfactory re-stocking of areas clear felled in all the new conversion plans. In Allapilli, however, some apprehension is felt, while in Hoshangabad a somewhat gloomy view has been taken of the results in Bori. It is perhaps not surprising that the localities where most misgiving is felt are precisely those where grazing is almost absent.

(*b*) *Coppice regeneration.*—The recent working plans for the teak divisions nearly all prescribe conversion to even-aged forest: as far as possible, areas with abundant established advance growth already present are placed in the block under conversion. In the conversion operations, however, such advance growth is usually cut back and the regrowth, together with the coppice of the felled overwood, comprises the new crop. Teak coppice growth is reported to be excellent in almost all divisions in which conversion plans have been introduced. In Hoshangabad the maximum girth of 4 year old coppice is reported to be 15 inches while 13 inches is very common; it has been remarked, however, that at this stage there is a very marked falling off in girth increment. In view of this falling off, the advisibility of cutting back advance growth and poles and the consequent sacrifice of increment, have been the subject of considerable debate and some officers now advocate the retention of all fairly well grown advance growth and poles to form part of the new crop. It is argued that by felling such poles we are sacrificing much increment and making a fetish of obtaining a completely even-aged condition. Against this it is contended that the growth of teak coppice is so rapid that the actual incremental sacrifice is very small. The danger appears to be that the teak coppice growth, though amazingly fast for the first few years, rapidly slows down and would actually take a long period to attain the size of the pole which was sacrificed. In Yeotmal it is reported that the cutting back of teak regeneration below 9″ in girth gives unsatisfactory results, especially in the poorer quality areas: the resultant coppice is switchy and straggling.

The advisability of the retention or otherwise of teak poles and advance growth is one which can only be decided by careful research. It is now therefore proposed to lay out experimental plots to compare the increment in clear felled areas and in areas in which poles or advance growth have been partially retained.

In the first coupes worked under the conversion system, advance growth of all trees of inferior species were almost invariably clear felled. In such clear fellings, teak being a very urgent light demander and a very strong coppicer is placed at a very distinct advantage over almost all other species: teak coppice commonly attains a height of 15'—20' in 4—5 years whereas the coppice of other species is seldom more than half this height. At the same time, the coppice of inferior species is very much more liable to damage by the browsing of deer. The present system of more or less clear fellings thus obviously tends to the progressive elimination of other species and the production of an almost pure teak forest. To guard against this danger it is now generally agreed that wherever possible well grown poles of inferior species should be reserved, particularly such trees as are not strong coppicers.

It is usually prescribed that clear felled coupes may be opened to grazing with the Conservator's sanction, as soon as the coppice is out of danger from grazing by cattle; such opening is desirable in order to avoid the very grave danger from fires. Teak coppice resulting from felled trees or advance growth cut back, is usually out of danger from grazing after 5 years, whereas most other species probably require 10 years. To reduce the period of fire danger, early opening is essential; such early opening, however, is likely to endanger the regeneration of other species and provides a further reason for the reservation of poles and advance growth of miscellaneous species to form part of the future crop and to produce a desirable degree of mixture, with the teak.

A new plot, experimental plot No. 6, was laid out in the Bhimaram felling series in South Chanda division in order to study the effect of *Petalidium* on teak regeneration. It has been sub-divided into 5 sub-plots. On one the *Petalidium* has been uprooted and burnt, in the second it has been uprooted and removed, in the third cut and removed, in the fourth cut and burnt while the fifth is a control. The coppice shoots and seedlings were enumerated and numbered serially in each sub-plot.

Experimental plots 8 and 9 in Betul which were laid out in 1931 to compare the teak coppice growth under clear fellings and under an overwood, were also visited. Teak coppice is distinctly more vigorous in the clear felled area, indicating that teak responds best to complete opening of the canopy.

(ii) *Shorea robusta (sal).*—In Balaghat it is reported that, as was expected from the excellent seeding and the timely rainfall, the natural

regeneration of *sal* was very satisfactory. There was very little frost during the last three years, 1929 being the worst frost year. Due to this absence of frost, the seedlings in the Supkhar range are coming up well and several blanks are rapidly filling up. Similarly in Mandla it is remarked that in the absence of frost, regeneration conditions in Motinala range has improved.

In Mandla division, with a view to find out what conditions will induce natural regeneration, certain experiments have been started by laying out plots in grazed and ungrazed areas in the *sal* forests near Kanha. Some of these plots have been burnt and thinned, others burnt and unthinned, some unbrunt and unthinned, the remainder unburnt and thinned. The seedlings were counted before burnings and thinnings were carried out. The number of seedlings will be counted annually to see the effects of each type of treatment on natural regeneration. Similar plots were laid out in Balaghat division.

In Raipur, the first division in the Central Provinces in which *sal*-high forests were worked under a system of conversion to even-aged forest, the results of 8 years working appear, on the whole to be very satisfactory, and regeneration conditions in the worked coupes are generally very good.

As mentioned last year, fire is the chief danger in these regenerated areas. Owing to the very limited grazing demand in this tract it is usually impossible to reduce this danger by early opening of the coupes to grazing. It is reported, however, that coppice growth has been so rapid, following the cutting back of 5-year-old regeneration which had been burnt, that the actual loss of increment is less than might be expected.

(iii) *Bamboos* (*Dendrocalamus strictus*).—Sporadic seeding of bamboos occurred in some areas in the Melghat and was followed by reproduction where grazing was not excessive. In Bhandara division, where bamboos seeded some years back, regeneration is reported to be good. In Jubbulpore where bamboos flowered gregariously between 1929 and 1931, regeneration is reported to be satisfactory in moderately grazed areas and dense in coupes closed to grazing. Where grazing is heavy, seedlings are absent and bamboos have been exterminated. This would indicate the silvicultural necessity of closure to grazing after flowering; no provision for such closure at present exists in any of the working plans.

It has been observed and reported from several divisions that after about 4 years, bamboos recover from clear felling. In Seoni division, clear felling is said to have stimulated the growth of bamboos. In several felling series in Rahatgaon range, Hoshangabad division, however,

the bamboos appear to have permanently suffered especially in coupes where the felling refuse was burnt.

North Chanda.—Experimental plots Nos. 1 and 6 which were laid out in order to observe the progress of regeneration in bamboo areas, were clear-felled two years ago. The results appear to indicate that the removal of the bamboo alone is all that is necessary for regeneration to establish itself.

Betul.—Experimental plot No. 7 was laid out in 1931 in order to determine the effect of fire on bamboos and grass. Observations show that bamboos are less healthy in the burnt than in the unburnt area.

(3) *Seed.*

The seeding of teak is reported by most divisions to have been good. *Sal* seeding was abundant in Motinala range of Mandla division and in Balaghat division. The *harra* (*Terminalia chebula*) crop was good in Balaghat but poor elsewhere. A general flowering of bamboo occurred in parts of Hoshangabad and Betul divisions.

All India Teak Seed Origin Experimental Plots.—The site of the teak origin plantation of ·5 acre at Baretha in Betul is probably unsuitable and it is certainly inconvenient.

Observations were continued in the all-India teak seed origin plots on gneiss and schist in Bilaspur division.

(4) *Nursery Work.*

Owing to the transfer of the headquarters of the silviculturist to Nagpur, the experimental nurseries at Betul and Balaghat have been abandoned. In consequence of the reduction in staff, it is unlikely that this nursery work can be continued as it is probable that grazing investigations and problems of natural regeneration of teak and *sal* will fully occupy the reduced staff.

(5) *Artificial Regeneration.*

(i) *Tectona grandis, Teak.*—Artificial regeneration was attempted in a number of divisions, but usually only on an experimental scale. The most important work was undertaken in Bilaspur division from which considerable success has been reported. The work has been continued on the *dona* system in which the weathered teak seed on germination is pricked out into small cups made of leaves, which are planted out in the forest as soon as the rains break. The great feature of the *dona* or leaf-cup system is that it enables the plant to be removed to the jungle with very little disturbance to the root system and that rain is not necessary for starting plantation operations.

In these operations, an area of 35 acres was clear-felled and planted in June-July 1932 with teak in mixture with *shisham* (*Dalbergia latifolia*). *Boga* (*Tephrosia candida*) was sown between the lines to act as a nurse, but its germination was unsatisfactory and success was very limited. The percentage of casualties of teak in March 1933 was less than 7 per cent. : a maximum height growth of 6½ feet and average height growth of 9 inches had been attained. Casualties were also replaced in the plantations made during the two previous years. Height growth of teak in the 1931 plantation recorded at the end of March 1933 averaged 5·4 feet while the maximum was 13·5 feet.

Plantation work was continued in the Berar divisions by agri-silvicultural methods but owing to the agricultural slump this work has now largely lost its popularity.

(ii) *Babul* (*Acacia arabica*).—In West Berar, 324 acres were restocked with *babul* mixed with *nim* (*Melia indica*) by agri-silvicultural methods. The lines were sown 18 feet apart by lessees, in combination with cotton under the terms of their agreements. Germination was fair but on account of the heavy rain, re-sowing was necessary in certain localities. *Babul* was similarly introduced with *nim* over an area of 39 acres in Amraoti. In Yeotmal, *babul* is now no longer grown with field crops ; owing to the poor shallow soil, it soon shows signs of decay and has suffered from the attacks of a borer, *Coelosterna scabrata*. It is also unpopular with the cultivators and so in certain areas, it is now being cut out and replaced with other species.

(7) *Thinnings and Cleanings.*

Thinnings.—It is generally agreed that thinnings proper cannot usually be carried out in the uneven-aged forests of the Central Provinces. True thinnings will only be possible when areas now under conversion grow up in a dense even-aged canopy. Even in patches of even-aged poles, the utility of thinnings is questioned by some officers who suggest that the forest has grown up in too irregular a fashion or that the treatment has too long been delayed for any beneficial results to follow. This is a matter that perhaps could only be proved by measurements of increment in thinned and unthinned plots in unconverted forests. It is now proposed to make arrangements to lay out such plots.

In mixed forests, thinnings have often been prescribed in recent plans, even before conversion. In such forests, however, where the chief demand is charcoal or fuel it is now generally agreed that thinnings are of little silvicultural benefit and merely tend to diffusion in working with little financial profit.

In teak forests, the chief danger of thinnings is recognised by many officers to be the progressive elimination of trees of mixed species, whose

extermination is subsequently hastened when the same area is treated by clear-felling. A judicious retention of trees of mixed species, even in preference to teak, is now therefore usually recommended.

In *sal* forests, particularly in Mandla and Balaghat, a vast quantity of unsaleable material results from thinnings. This unproductive expenditure has led to a suggestion that the silvicultural prescriptions of the new plans in these divisions are perhaps premature. In Mandla it is remarked that it is usually the badly grown *sal* poles which are removed in thinnings and that such poles are unsuitable for pit props which is the only present form of demand for poles.

Working plans prepared during the last 10 years generally prescribe thinnings everywhere on a 20-year rotation. As has been suggested above, such thinnings have often been found unnecessary owing to the composition of the crop or the open character of the jungle. Divisional Forest Officers have therefore wisely used their discretion in limiting such operations to those areas where they were likely to prove of silvicultural benefit and financially profitable.

Cleanings and Cutting Back.—In departmentally felled teak coupes it is now the usual practice to cut back all teak advance growth as a preliminary operation. Otherwise it is likely to be overlooked in the felling *débris* and consequently regeneration conditions suffer. At the time of fellings subordinates are impressed with the importance of shifting felled teak logs some distance from the stumps so that the teak coppice may grow up without constraint. When fellings and extraction have been completed the coupe is again examined. All damaged stems are felled and care is taken that the young coppice is clear of all felling refuse.

In some divisions the thinning out of the teak coppice shoots resulting from clear fellings carried out during the past 5 years has already been undertaken. Elsewhere it has been suggested that however desirable this operation may be, it can more suitably be postponed until the produce is saleable.

In coppice coupes worked by contractors the latter are usually required in accordance with the prescriptions of the Forest Contract Rules, to fell everything even down to the smallest size. At first contractors showed some reluctance to comply but they are gradually learning or being induced to clear-fell their whole coupes, section by section.

Certain plans still prescribe and some officers still favour the retention in coppice or regenerated areas of advance growth up to 9″ or 1′ girth. Such advance growth may be useful in frost areas and may result in a saving of several years increment, particularly in the case of poor coppicers. The chief disadvantage of its retention would appear to be

that much of it is badly grown or suppressed or is damaged in the fellings ; in consequence, subsequent cutting back is frequently necessary.

In certain dense bamboo areas such as Bori, repeated cutting back of bamboos over teak regeneration was found desirable in order to free the teak regeneration which had grown in dense shade and did not readily respond to the sudden admission of light. In more open types of forest where the growth of teak coppice was more rapid, the teak succeeded in getting ahead of the bamboos and consequently no cleaning has been necessary.

(11) *Miscellaneous.*

Pasture Experiments.—The grass weighment experiments reported last year were continued and the results were summarised by the Silviculturist ; Mr. George states that the results obtained appear to be inconclusive. He remarks " Personally I am far from satisfied that the weighment methods, though simple, can possibly give adequate results. A detailed study of each plot is required over a period of years so that the effects of continuous grazing on the actual grasses growing can be observed. We know generally speaking that heavy grazing results in the elimination of the edible grasses and the appearance of coarse grasses and weeds. Closure to some extent reverses the process but mere weighments cannot accurately show what is happening owing to the differences of weight of the various grasses ".

II.—Working Plans and Statistics.

(1) *Working Plans.*

(*a*) *Alterations to existing schemes and working plans.—Raipur.*— Revision of the working plan for the Raipur *sal* forests was undertaken during the year. This plan was written 9 years ago and was the first in the Central Provinces to prescribe conversion of *sal* high forest to an even-aged condition. The conversion operations and regeneration conditions in Periodic Block I are reported to be very satisfactory but certain changes have now been found necessary.

(*b*) *New Working Plans.—Nimar, South Mandla* and *Bilaspur.*— The sanction of government to the introduction of these plans was received during the year and plans for North Mandla, Saugor, Nagpur-Wardha and Betul divisions were under preparation. These are the last plans prepared under the direction of a Superintendent of Working Plans ; Conservators now control the preparation of working plans.

(*c*) *Operation of recently introduced plans.*—The Working Plans division has been in existence for 7½ years, during which time 14 plans in all have been completed. As the work under these new plans extends, valuable observations are being made regarding their operation.

In the Bilaspur plan a somewhat complicated system of yield calculation has been prescribed in the *sal* high forest working circle to control fellings both in Periodic Block I and in the unallotted area. This system has already proved impracticable and arrangements have, therefore, been made to modify the plan. In this connection it may be remarked that in almost every instance where volume control in however simple a form, has been prescribed in recent plans in the Central Provinces, such control has been found impracticable, chiefly owing to the very large proportion of unsound timber still present in the forests.

Balaghat.—In view of the almost complete lack of demand for anything except sleepers, it is very doubtful whether the conversion fellings prescribed in the plan can be carried out in the Blue Block coupes in the *sal* forests of Baihar range.

The Hoshangabad report advocates very generous reservations both of teak poles and of poles of miscellaneous species, particularly in the more remote coupes where teak poles are unsaleable, and in forests where teak is tending to become pure. Where teak poles occur in even-aged groups, the recommendation is perhaps wise: elsewhere excessively conservative treatment may result in a sacrifice of the advantages of an even-aged condition.

Melghat.—The revision of this working plan is under consideration and it is hoped to be able to introduce a modified form of the conversion system in the more favourable areas. Repeated cycles of improvement fellings have tended to reduce the whole forest to an even-aged young crop, while the very large size of the annual coupes has made it difficult to carry out all the silvicultural work demanded. In the *Lantana* areas, it is apparent that some form of artificial regeneration will be necessary.

South Chanda.—The scarcity of teak regeneration in certain areas worked under the Allapilli plan has caused considerable apprehension. In consequence, artificial methods of regeneration are now being resorted to. The Conservator has stressed the importance of the retention of trees of miscellaneous species in the teak forests of this division and of the cutting back of teak advance growth, matters which were not provided for in the working plan.

(2) *Yield Tables.*

Sample plots.—There were 86 sample plots on the provincial list during the year under report; the distribution of these is as follows:—

Eastern Circle	52
Central Circle	19
Western Circle	15
	86

The distribution by species is given below :—

Babul (*Acacia arabica*)	1
Bhirra (*Chloroxylon swietenia*)	1
Carari (*Cleistanthus collinus*)	2
Anjan (*Hardwickia binata*)	1
Chir (*Pinus longifolia*)	2
Bija (*Pterocarpus marsupium*)	1
Sal (*Shorea robusta*)	38
Teak (*Tectona grandis*)	37
Saja (*Terminalia tomentosa*)	1
	86

Measurements were taken in teak volume increment plots 1, 2, 3 and 4, South Chanda.

III.—Miscellaneous.

(1) *Climbers and Weeds.*

Lantana.—During the year, Mr. Maitland, by calling in the assistance of 5 elephants, inaugurated a new phase in the campaign against *Lantana* in the Melghat division. An article written by him has already appeared in *The Indian Forester.* Subsequent calculations have shown that one elephant can do as much work as 27 men in very dense growth or as much as 15 men when the *Lantana* is more scattered. This pest is reported in several divisions.

In Chanda, *Petalidium barlerioides* is a grave obstacle to regeneration. The matter is under investigation by the silviculturist who laid out experimental plots during the year to study possible methods of treatment.

In Betul division, owing to the very rank growth of *mahul* (*Bauhinia vahlii*) it has been found necessary to abandon clear fellings in one felling series, as the coppice growth was becoming smothered by the climbers and the cost of repeated climber cutting was found to be prohibitive and not very effective.

(2) *Fire.*

The present modified system of fire protection is criticised by several officers who emphasize the danger that the protective burning which is carried out in areas not subject to strict protection may get out of control or be unduly delayed. However desirable a reversion to the old system of universal complete protection may be, the present restriction of funds renders such a reversion impossible. In the meantime, the success or failure of the present modifications depend upon thorough burning being carried out as early as possible in the season.

The extension of clear felling methods to almost every division of the province renders the protection of regenerated areas an ever-increasing

responsibility. In order to minimise the risk of fires entailed by the presence of rank grass in recently felled coupes and in regeneration areas, conservators are now empowered to open such coupes to grazing as soon as the young crop has grown beyond serious danger of damage from the browsing of cattle.

(3) *Grazing.*

The reconciliation of the conflicting demands of forest management and of the provision of grazing continues to be one of the most difficult problems with which the Forest Department is faced. While it is now universally recognised that periodic closures and restrictions in grazing incidence are necessary no less in the interests of the maintenance of the pasture than in order to preserve the forests and to secure regeneration, such restrictions can be imposed only in progressive stages, as sudden exclusions are bitterly resented, especially when their reason is not appreciated. In accordance with the recommendations of the Royal Agricultural Commission, Government have recently ordered a reclassification of all reserved forests, according to their relative importance for the production of timber and fuel or for the satisfaction of the grazing demand. When the classification has been completed it is proposed to formulate a policy for the regulation of grazing in each class of forest.

The experiments which have been initiated, in consultation with the Agricultural Department, with the object of investigating grazing incidences and the effect of various closures on the quality of the pasture have not yielded any definite results. It is of the utmost importance that these experiments should be continued and developed as they are likely to give valuable data for future regulation. The progressive increase in the number of cattle in the province combined with a constant reduction of grazing areas available outside forest reserves, renders the grazing question a problem which year by year grows more difficult of solution.

(4) *General.*

Records.—53 publications were added to the library during the year. General files were opened for 23 new subject heads and one Specific file was added. Additions to the collection of photo prints and negatives numbered 102 and 11 respectively.

COORG.

I.—Experimental Silviculture.

(5) *Artificial Regeneration.*

Regeneration experiments with Sandal (Santalum album) North Coorg. —Somwarpet Range.—The method of regenerating sandal with a field crop of *ragi* (*Eleusine coracana*) was discontinued during the year.

The method of dibbling sandal under shade the undergrowth only being removed—was continued in Aygoor, Kargode, Kattepura, Hudgur and Hirikere. In the first three areas the spacing was 6′×6′. At Hudgur and Hirikere it was 18′×12′. *Dhal* (*Phaseolus* and *Cajanus*) was sown with sandal with *Cassia siamea* as a secondary host instead of *Erythrina indica*, as the latter was found to be attracting game. The germination in all plots was about 95 per cent., but owing to drip all the seedlings died. It is evident therefore that sandal cannot be raised in Coorg under heavy shade ; the *Cassia siamea* and *dhal* also failed. These areas have since been felled over leaving as advance hosts about 10 trees per acre, and it is proposed to repeat the experiments under these altered conditions in 1933-34.

The following table shows the number of seedlings found after enumeration in March 1933 in the four plots of one acre each opened in 1931 at Hirikere :—

Plot No.	No. of sandal seedlings planted originally.	No. of surviving plants in March 1933.				
		Sandal.	*Melia.*	*Terminalia.*	*Cassia siamea.*	*Acacia farnesiana.*
1	400	75	*Nil.*	*Nil.*	120	*Nil.*
2	400	60	2	,,	75	,,
3	400	73	*Nil.*	,,	*Nil.*	3
4	400	65	,,	,,	,,	2

From the above results it is obvious that of the species tried, *Cassia siamea* may be considered as the most suitable host for sandal.

Fraserpet Range.—The method of regenerating sandal with a field crop of *ragi* (*Eleusine coracana*) was continued during the year with the following results :—

Locality.	Area in acres.	Cost per acre up to end of March 1933.	Total No. of sandal plants survived at the end of March 1933.	Height of tallest plant.	Yield of *ragi* in *pallas* per acre.	Value of *ragi* at Rs. 4 per palla.
		Rs.				Rs.
Attur . .	16	84	5,896	4′—9″	24	96
Meenkolli . .	7	10	1,920	3′—7″	..	..

Remarks.—Attur.—Ragi was sown and collected departmentally. *Dhal* plants are dying, but sandal is growing well.

Meenkolli.—Ragi was sown by Kurubars and the yield taken by them. In this area also *dhal* plants are dying, though sandal is growing well.

In both the areas *Erythrina*, *Cassia siamea* and *segade* (*Schleichera trijuga*) seeds were dibbled in addition to *dhal* (*Phaseolus* and *Cajanus*) as host plants. *Erythrina* and *Cassia* germinated well, but *segade* was a complete failure.

In the 1931 areas, the failures of both sandal and host plants were replaced. *Cassia* and *Erythrina* were used as hosts and the results are so far very encouraging. The following table shows the stock of plants in them :—

Locality.	Area in acres.	Total No. of sandal plants surviving at the end of March 1933.	Height of the tallest plant.
Attur	14	5,126	9′—6″
Meenkolli	7	2,490	8′—8″

The 1931 area (4 acres) at Dubare which was dibbled with sandal under shade without burning, *Lantana camara* only being removed, had a stock of 1,047 seedlings at the end of March 1932, but there were only 154 seedlings on 31st March 1933, the tallest being 4′-9″. The sandal in this area is not promising.

South Coorg.—Sandal regeneration with a field crop of *Eleusine coracana* was continued during the year. Only one area was taken up, a plot 11 acres in extent alongside the Ganagur road. As usual the area selected was one densely covered with *Lantana*. The area was clear-felled by the end of October 1931, and burnt about the middle of March 1932. After heaping and reburning of the refuse remaining unburnt, the area was staked 6′×6′ and dibbled with untreated seed by the 25th April 1932. A second dibbling with treated seed was completed by the 25th May 1932. At the same time seeds of *dhal* and *Cassia siamea* were dibbled as host plants. The seeds of the host plants germinated well, but the germination of sandal was a complete failure, due, it is reported, to bad seed. Two other sowings were done, but in spite of this only 5 per cent. germination in all was obtained.

The area has since been planted up with the excess sandal plants found in the 1931 sandal area, much in the same manner as teak stumps. Up to the end of March 1933 the stocking was 30 per cent., the average height being 2 feet and the tallest plant 4½ feet. The cost per acre up to the 31st March 1933 was Rs. 36-11.

In the 1931 area at Gangur, *Erythrina indica* was removed as it was found that browsers are attracted by it, and *Cassia siamea* seed was dibbled. The latter proved a failure due probably to late sowing. The sandal however is doing exceedingly well. As a result of enumeration

done in January 1933, the stocking was found to be 80 per cent, and the average height 4'-6" and the tallest plant 8'-6". The removal of excess plants from this area, referred to above, appears to have greatly helped the growth of the sandal. No browsing was observed. Watchmen were employed at night to keep game away from the area. The total cost of this area up to the end of October 1932 works out to Rs. 34 per acre.

In the Bambookadu 1918 sandal area of 50 acres, as the sandal trees looked very poorly and as it was thought that this condition was due to want of sufficient hosts, 409 sandal trees were uprooted, leaving the remaining trees about 30' apart. No heartwood was obtained from these trees as they were still young. Six more trees attacked by spike which appeared in this area for the first time in October 1931 were uprooted and burnt during the year. The total cost of this plantation up to date works out to Rs. 96 per acre. The average height is about 20 feet and girth about 12 inches.

(11) *Miscellaneous.*

(1) *Spike Disease.*—Investigation of spike disease on sandal was carried out in co-operation with the Indian Institute of Science, Bangalore and the Forest Research Institute.

In July 1932, 404 apparently healthy sandal trees were pollarded in the old Chinnanhalli manurial plots in order to see if marked symptoms of spike were present. Up to 31st March 1933, 141 trees were found to be definitely spiked. The symptoms began to manifest themselves with the flush of new leaves.

A healthy tree was also pollarded in the Bambookadu 1918 plantation during June 1932 with the same object by Mr. Sreenivasaya of the Indian Institute of Science, Bangalore. So far no signs of spike have been noticed on it.

Four other cases of spike were noticed during the year, one early in September 1932 on the Somwarpet-Kodlipet road near the 34th milestone, one on 14th November 1932 in Kyasaralli village and two during December 1932 in Aygoor village in Somwarpet range.

(2) *Teak Defoliation Experiment.*—Observations are still being recorded and reported separately.

(3) *Burning of Teak Plantations in the second year.*—A teak *kumri* (temporary cultivation) of 10 acres close to Santhedari fire line in Dubare was opened during the year. The stock in this area at the end of March 1933 was 8,674 seedlings. The area was reburnt and seedlings cut back in March 1933. The experiment is still in progress.

During 1932 an area of 70 acres at Devamachi was dibbled with teak 6'×6' apart and all but 4 acres were kumried with *ragi* (*Eleusine*

coracana). In December 1932, the stocking was about 80 per cent. and the tallest plant 2'-6" in height. The yield of *ragi* was poor, a root fungus having ruined the crop. In March 1933 the whole area was burnt and cut back, except a control plot of 5 acres in the centre. Observations will be recorded on the condition of the plants in both burnt and unburnt plots. The total cost up to the end of November works out to about Rs. 45 per acre.

Also, 5 acres in each of the 1932 regeneration areas at Kalhalla and Nagerhole were sown with mustard with the object of ascertaining whether this would keep down the weeds, but this was found to have no appreciable effect.

II.—Working Plans and Statistics.

The revised working plan for certain of the Eastern Coorg forests was completed during the year.

MADRAS.

I.—Experimental Silviculture.

(1) *General.*

Much of the experimental work done this year has been Stage I (*a*) investigations in experimental gardens of which there are now six. Though most of these are initial investigations some of them were done to verify the results of former larger scale work which had not given absolutely conclusive results. In stump planting experiments, some of the work covered by Messrs. Champion and Pant's publication (*Indian Forest Records*, Volume XVI, Part VI), has been repeated, indicating to what extent the Forest Research Institute results hold good in Madras conditions. The most important result of the year's work is that it has placed beyond all reasonable doubt the enormous advantage of pre-monsoon planting in the conditions prevailing in our more important teak tracts.

(2) *Natural Regeneration.*

(i) *Natural regeneration by seed.*—(*a*) *Hopea parviflora.*—The plots opened in Karian-shola to observe the effect of shrub cutting and canopy manipulation on natural regeneration of *Hopea* showed very little growth ; that in which shrubs were cut and the middle storey trees girdled showed more than the others. Considerable browsing followed the shrub cutting in the unfenced set of plots. Further plots were opened to observe the effect of soil working and of isolation by trenching on unestablished

natural regeneration. Similar sets of plots have been opened during the year for *Mesua ferrea.*

(*b*) *Artocarpus hirsuta.*—The District Forest Officer, South Mangalore, records that cutting and burning shrubs under seed bearers in 1930 has, by 1933, resulted in a sprinkling of natural regeneration about 5 inches high—about 70 per acre.

(*c*) *Pterocarpus santalinus.*—Plots maintained by the District Forest Officers, North and South Cuddapah, since 1927 to compare the effects of complete fire protection and of early burning with and without cutting back on unestablished natural regeneration among heavy grass indicate that early burning is a satisfactory compromise.

(ii) *Natural regeneration by coppice.*—Four plots have been opened in dry scrub jungle to study the effect of different heights and methods of cutting on the vigour of the coppice shoots and on stool mortality.

(iii) *Natural regeneration by root suckers.*—A preliminary experiment in trenching 12″ deep at distances varying from 5 to 15 feet from trees of the six commonest species in the dry fuel forests of Chittoor division, *viz., Diospyros melanoxylon, D. chloroxylon, Maba buxifolia, Ixora parviflora, Gymnosporia emarginata* and *Albizzia amara* produced practically no suckers by March 1933. The District Forest Officer, Nellore, trenched round 50 *Strychnos nux-vomica* trees, severing the roots in 25 trees and only wounding them in 25. Many suckers appeared from the severed roots, none from the wounded ones. Roots of *Sapindus emarginatus* unintentionally severed also produced suckers.

(3) *Seed.*

(i) *Seed years.*—The quality of seed years for all the most important species in the different districts was recorded as usual.

(ii) *Seed pre-treatment.*—Routine pre-treatment tests were made with 21 species, the treatments used being cold, hot and boiling water, with an untreated control in each case. Seed purity per cent. and seed weights were recorded. The germinative capacity of seed of the following species was not appreciably improved by any of the pre-treatments used,—*Acrocarpus fraxinifolius, Dalbergia latifolia, Gluta travancorica, Gmelina arborea, Pterocarpus marsupium,* teak, *Acacia sundra, Albizzia amara, Anacardium occidentale, Cassia fistula, Cassia marginata, Prosopis juliflora, Prosopis spicigera, Pterocarpus santalinus.* All these species except *Acrocarpus fraxinifolius, Cassia fistula* and *Pterocarpus santalinus* possess a reasonably high germinative capacity untreated. Treatment with boiling water is beneficial with *Acacia auriculiformis, Acacia cyanophylla* (very marked) and *Cassia siamea,* but harmful for nearly all of the other species tried. Soaking in cold water appears to improve the germinative capacity of seed of *Terminalia tomentosa, Xylia xylocarpa,* and

Chloroxylon swietenia. Seed of *Pterocarpus santalinus* sown after removal of the outer seed covering gave far better results (in a single test) than seed sown intact. In the case of *Terminalia chebula*, a notoriously bad germinator, a germinative capacity of 37 per cent was obtained by sowing the kernel after removing it from the nut, but repetitions were a failure owing to damage by white ants.

(iii) *Seed storage.*—Test made at intervals, usually of a week, with seed from the same sample gave the following results :—

Gluta travancorica.—Seed collected May 1932. First test 3rd July 1932. Stored in gas. 60 per cent to 65 per cent in first 4 tests ; from 5th to 9th week 30 to 40 per cent ; 75 per cent in 10th week, and 15 per cent. in 11th and 12th week.

Acrocarpus fraxinifolius.—Seed collected 4th April 1932. Stored in bags ; first test 2nd July 1932. Gave results varying from 1 to 14 per cent, with an exceptional 24 per cent in 6th week. No sign of seed being affected either way up to 14th week.

Dichopsis elliptica.—Seed collected 15th July 1932. Stored in bags. First test 19th July 1932. Gave 24 to 36 per cent in first 6 tests. There after a falling-off to 7 per cent in 10th week and nil in 11th week.

Hopea parviflora.—Seed collected 28th June 1932. Stored in bags. First test 3rd July 1932, tests were at 4 days' intervals. The first three tests gave 60 per cent to 67 per cent. Thereafter a rapid fall to 1 per cent on 26th August 1932 and nil thereafter.

Dysoxylum malabaricum.—Several samples collected between 30th July 1932 and 6th October 1932 gave results varying from 15 to 35 per cent, there being apparently some tendency for germinative capacity to fall off after the first week or two.

Cassia marginata.—Sown immediately after collection in May 1932. Gave practically no germination. Seed from the same sample sown three months later had a germinative capacity of 50 per cent.

Chloroxylon swietenia.—Collected in 1931 and tested in 1932 appeared to be completely infertile.

(iv) *Sorting of seed.*—Tests of teak seed sorted into different sizes indicated that smaller seed gives earlier and more even germination. Plants raised from seed of different sizes showed no difference in survival per cent though in two cases out of three, the growth from the random sample seed was significantly ahead of growth from selected seed, either large or small.

(*v*) *Seed bearers.*—Teak seed collected separately from trees of different girths, *viz.*, (*a*) over 10 feet, (*b*) under 3·5 feet and (*c*) 5 to 6 feet, showed no difference in germinative capacity. Plants raised from the three classes of seed showed, in both the localities where the test was done, inferior

height growth from trees in their prime, as compared with larger and smaller trees (significant in one case, and nearly significant in the other).

Germination tests with seed of *Santalum album* from trees of girths varying from 29 inches to 65 inches disclose no correlation between size of seed bearer and the germinative capacity of its seed.

(vi) *Seed Origin.*—Investigations into the effect of seed origin were continued, both for different local origins and for the All-India investigation. The difficulty of obtaining even germination of seed from some parts of India has upset planting experiments and necessitated the use of stumps in order to avoid initial differences.

Results from earlier plots are suggestive but not conclusive. In most cases the local seed has after 2 or 3 years shown better growth than seed from other parts of Madras. In preliminary short term investigations of the All-India origins at Nilambur (Experimental Plot 107), South Bombay and Walayar showed after 2 years' significantly better growth and North Burma significantly worse growth than Nilambur origin. South Burma seed germinated too late for comparison. At Palghat, Walayar (local) seed gave significantly better growth than Nilambur or Mysore origins, the latter being by far the slowest of the three. Most of the above are open to some criticism on the grounds of initial incomparability, and complication by replacements.

Short term experiments at Anaipadi opened in 1932 add further reliable evidence in favour of local (Mount Stuart) seed, which after one year's growth is significantly superior to South Burma seed (11·2″±1·66) and to Mysore seed (8·6″±1·76). Nilambur seed was slightly but not significantly worse than local seed (2·0″±1·96). At Nilambur, the local seed proved significantly superior to Travancore, South Burma, and North Burma—superior but not significantly so to Mount Stuart (3·1″± 1·8), but is beaten by South Bombay (6·6″±2·0). The success of the South Bombay seed is noteworthy in view of the superior results it gave in Experimental Plot 107 (above).

The two seed origin experiments with *Dalbergia latifolia* (Experimental Plots 80 and 100 of South Coimbatore) continue to show that local (Mount Stuart) seed gives significantly better growth than Nilambur and worse growth than Bolampatty origins, but the results are not entirely reliable. A repetition reversed the order placing Nilambur superior (4·7″±0·65) and Bolampatty inferior (1·9″±0·52) to the local seed.

(4) *Nursery Work.*

Experiments at Chittoor showed that the following species give better germination in shaded seed beds than in open beds :—*Acacia*

cyanophylla 51/24 per cent. *A. sundra* 90/38 per cent. *Pterocarpus santalinus* 58/23 per cent.

The following list shows species which exhibit preference or otherwise for shaded beds as judged by seedling growth :—

Preferring shade—Anacardium occidentale, Prosopis juliflora, P. spicigera, Chloroxylon swietenia.

Preferring open.—Acacia auriculiformis, A. cyanophylla, Cassia marginata.

Indifferent.—Acacia sundra, Albizzia amara, Cassia fistula, C. siamea, Pterocarpus santalinus.

(5) *Artificial Regeneration.*

(i) *Stocking of felling gaps.*—Work on a considerable scale has been continued in several districts both in mixed deciduous forest and evergreen rain forest. In the latter results are not up to expectations, whereas in the former results are very promising, though it is still early to claim that success is assured.

(ii) *Direct sowing.*—In simple coppice fuel coupes, direct sowing in burnt patches or lines to replace the wastage from stump mortality has given encouraging results. In Vellore 18 months after sowing *Albizzia lebbek* reached 12 feet, *Melia indica* 6 feet, *Albizzia amara* 3 feet, *Cassia siamea* 9 feet, all with a satisfactory number of survivals. *Prosopis juliflora* and *Acacia ferruginea* in North Coimbatore gave thriving plants from 4 to 6 feet high after two seasons' growth. *Acacia leucophloea, Zizyphus jujuba, Z. xylopyra* and *Dolichandrone crispa* also gave good results.

Experiments in direct sowing under shade in these arid tracts made in the Chittoor experimental garden with 12 species indicated strongly in favour of sowing in the open. This is confirmed by the poor results obtained by the District Forest Officer, North Salem, from sowings under shade in dry fuel forest.

The District Forest Officer, North Cuddapah, experimented with different intensities of burn before sowing and found no significant gain in height growth with brushwood heaped higher than 2 feet. Survivals tended to fall off in the more intense burns.

The District Forest Officer, Upper Godavari, has experimented since 1931 with broadcast sowings of teak (after a light opening of the canopy and burning) 5 years before clear-felling is due. Of two 10 acre plots treated one gave no success (its failure is attributed to the selection of an area unsuited to teak); the other shows distinct promise.

Anacardium occidentale raised by direct sowing on very poor laterite soil has thriven amazingly.

(iii) *Manuring.*—Experiments in adding different quantities of lime to soils deficient in lime gave no significant differences in the height growth of *Dalbergia latifolia* after two seasons. In the case of teak a significant difference in favour of the control (without lime) was obtained.

(iv) *Weed control and soil aeration.*—Four Stage I (*a*) experiments two with teak stumps and two with teak transplants, in which all the lines were kept clean weeded, and every fourth line was aerated monthly from September 1932 onwards to a width of three feet gave the surprising and consistent result that soil aeration has no beneficial effect by itself in the first year (*i.e.*, up to March). The controls, in fact, tended to show better growth than the aerated lines, though this only reached significance in one case. It should be noted however that the soils in question are naturally light and well aerated. Indications are given by measurements in May that at this stage soil working has a distinctly beneficial effect. An incidental point of interest clearly brought out by the monthly measurements is the well-marked resting period from mid-December to mid-March.

A large scale experiment in a second year teak plantation to compare the Nilambur practice of forking in 4-foot wide strips with the Wynaad practice of forking in 4-foot diameter circles round the plants showed a significant increase in growth in the forked strips (0·97 feet$\pm$0·30)=26 per cent again, by the following March. This clearly demonstrates the superiority of the Nilambur practice which is however more expensive.

A similar experiment in a first year teak plantation (Experiment 1 Begur garden), to compare the Nilambur practice of scraping in 4-foot lines in the rains and fork-weeding in 4-foot lines after the rains (weeds between the lines being cut), with the Wynaad practice of 4 weed cuttings between July and October accompanied by clean weeding and soil working to 18 inches diameter round each plant again showed the superiority of the Nilambur treatment. In November 1932 the mean heights were 9·36 inches (Wynaad practice) and 16·26 inches (Nilambur practice) and in March the figures were 9·6 inches$\pm$0·48 and 17·0 inches$\pm$ 0·60 respectively,—difference 7·4″$\pm$0·77. The Nilambur practice has given almost twice the height growth of the Wynaad practice. Note again the almost complete absence of growth from the end of November to March.

The continued effect of an inferior weeding treatment (and the importance of getting the greatest possible development in the first year) is brought out by measurements made in February 1932 and April 1933 in Experimental Plot 110 Nilambur, where four first-year weeding treatments, with teak planted in 1931, were compared. The layout and num-

ber of replications is acceptable. The treatment in the second year was the same for all :—

—	*Mean height in February 1932.*	*Mean height in April 1933.*	*Remarks.*
	Inches.	Feet.	
1. Forked in lines . .	18	5·3	Differences between forked-in lines control and all others are significant at both measurements. Difference between (2) and (3) which was not significant in February 1932 continued to be not significant in April 1933.
2. „ in circles .	15·8	4·6	
3. Scraped in lines . .	15·0	4·5	
4. Weed cut (control) .	10·8	3·5	

(v) *Effect of burning a teak plantation in the hot weather after formation.*—It has often been stated that burning stimulates teak. In order to test this one of two adjoining strips in a teak plantation was burnt in March and the stems cut back. The burn was poor, but by the following February the stems in the burnt strips showed a significant 24 per cent increase in height over the unburnt strips in spite of an initial difference in favour of the latter. The burn had no adverse effect on stocking.

(vi) *Stump Planting.*—(*a*) *Trial with various species.*—Stump planting with 18 species was tried, and the results classified according to the system adopted by Champion and Pant (*Indian Forest Records*, Vol. XVI, Part VI). Results agreed closely with the Forest Reseatch Institute tests with the exception of *Albizzia lebbek* and *Chikrassia tabularis* which were " A " (good) and " A/B " (moderately good) respectively. The following species not tried at the Forest Research Institute gave results as follows :—

Terminalia paniculata	A
Eucalyptus tereticornis	E
Cedrela odorata	B
Gluta travancorica	E
Vateria indica	E
Santalum album	A (?)
*Dysoxylum malabaricum**	E
*Mesua ferrea**	E
*Calophyllum elatum**	E
Prosopis juliflora	B/C
Acacia auriculiformis	D/E

* In evergreen forest under low shade.

(*b*) *Optimum season for stump planting.—Teak.*—In order to test further the advantage and reliability of early stump planting of teak, experiments in three localities were carried out in which stumps were planted fortnightly from the middle of April until the monsoon was established in June. The results were consistent for all localities and showed that (*a*) there is an immense gain in height growth in the first season, early (April) planting giving more than double, and in one case more than treble the height obtained by monsoon planting, (*b*) there is almost perfect stocking with early planting, (*c*) success is *not* dependent on what is usually considered good planting weather. (In one case 100 per cent success was obtained with stumps planted after 9 rainless days, and followed by 7 rainless days.) (*d*) There are comparatively small differences between the first three dates of planting (15th March, 1st and 15th April).

It seems almost certain that, except perhaps in the driest teak localities (rainfall under 60 inches), pre-monsoon planting is the method of the future. The immense advantage given by the start the teak gets over weeds or field crops more than outweighs any risk of bad stocking, and this risk can be insured against cheaply by providing a reserve of plants for stumping in June if necessity should arise.

Experiments in the Chittoor experimental garden with *Cassia siamea*, *Prosopis juliflora* and *Acacia auriculiformis* indicate that in the dry conditions (30 inches rainfall) there prevailing, rainfall incidence has a marked effect, the highest survival per cent being obtained in November, the period of the principal monsoon.

(*c*) *Stump planting. Effect of age of stock used.*—Teak stumps from beds sown in April 1931 and October 1931 were planted on 2nd June 1932. The older stock showed a slightly but not significantly greater height growth (0·4—1·1) and a marked superiority as regards survival, (80 per cent as against 58·5 per cent).

(*d*) *Stump planting. Effect of diameter of stump.*—Teak stumps of three sizes were compared. It was found that stumps thicker than a pencil grew equally well as regards height, but smaller stumps produced significantly poorer height growth. There was a falling off from 94 per cent survival with the big stumps to 77 per cent with the small, in the only one of the experiments in which the layout was entirely acceptable.

(*e*) *Stump planting. Effect of length of root.*—In two experiments with teak stumps no significant differences in growth in the first year were produced. The lengths of the root tested were 9″ and 4″ in one case, and 10″, 7″ and 4″ in the other. Survivals were lower with the short root length in one case (86/94 per cent) but in the other the figures were 4″ root—90 per cent, 7″—84 per cent, 10″—78 per cent.

A third experiment, not so reliable in lay-out, showed greatest survival and very significantly greater height growth for the longer root length.

(*f*) *Stump planting—Pits versus crow-bar holes.*—A repetition of last year's experiments under more carefully controlled conditions showed the slight superiority of pits as regards resulting height growth (4 per cent, 9 per cent, and 13 per cent increase only the last being significant). Survival per cent, which ranges from 73 to 97 is also in favour of pits.

A similar experiment comparing the Wynaad practice of planting in crow-bar holes after soil working with plain crow-bar holes (no soil working) showed a nearly significant difference of height growth (2·5″± 1·32) in favour of plain crow-bar holes. Survival per cent was also better for the latter (86 per cent/80 per cent). The soil was, however, naturally light.

(*g*) *Casualty replacement.*—The fate of 244 second year replacements (with stumps) in a teak plantation was watched. With normal attention 80 per cent had died by the following March and the rest were unpromising.

(9) *Underplanting.*

Underplanting in teak plantations.—Cephalostachyum pergracile sown direct at Nilambur is doing excellently. Other plots with the same species are moderately encouraging. It does better than the local *Bambusa arundinacea*. Attempts at underplanting with *Swietenia macrophylla* are doubtfully successful owing to browsing.

Underplanting in evergreen rain forest.—The success of underplanting with *Mesua ferrea* and *Calophyllum elatum* under evergreen forest shade suggests that there is a better prospect of success with this method than with attempting to stock felling gaps. Hence a systematic study of planting technique under such conditions with a large number of species has begun, and is in progress. The chief result obtained so far is the complete failure of stump planting under these conditions while entire planting in many cases has given satisfactory results.

II.—Working plans and Statistics.

(1) *Working Plans.*

(*a*) The Provincial Silviculturist has been in touch through the Working Plans Conservator, with Working Plans Officers in various districts, and proposed prescriptions regarding silvicultural and statistical work have been referred to him for criticism from time to time.

(*b*) The following statement shows the working plans under preparation in the Working Plans Circle, at the beginning of the year, those completed during the year, and the new plans undertaken.

No.	Working Plans under preparation at the beginning of the year.	Working Plans completed during the year.	New Working Plans commenced during the year.	Remarks.
1	Lower Godavari			
2	Tinnevelly		Madura.	
3	Palghat Ghat forests	Palghat Ghat Forests		
4	(*a*) North Coimbatore (*b*) Kollegal.	North Coimbatore.		
5	Wynaad Ghat Forests	Wynaad Ghat Forests	South Coimbatore.	

(*c*) The following Working Plans received the sanction of Government or the Chief Conservator of Forests during the year :—

1. Wynaad Ghat Forests of Wynaad Division.
2. North Coimbatore Forests.
3. Revised Working Plan for the Ghumsur forests, Ganjam district.
4. Working Plan for the Nallamalai forests of Kurnool West division.

(*d*) The cost of preparation of the above working plans, inclusive of establishment, varied from Rs. 0-0-4 per acre to Rs. 0-12-3 per acre, largely in accordance with the amount and intensity of the enumerations and stock mapping that were necessary.

(2) *Yield Tables.*

71 permanent sample plots were maintained of which 41 were re-measured during the year.

Three linear increment plots have been laid out for *Pterocarpus santalinus*, 1 for *Hopea parviflora* with *Mesua ferrea* and 2 for *Mesua ferrea* with *Dichopsis elliptica*.

(3) *Volume Tables.*

Additional data has been collected for the compilation of local volume tables for *Pterocarpus santalinus* in Chittoor division.

III.—Miscellaneous.

The specific and general ledger files now number 376 and 79 respectively. The re-arrangement of the plot files, photographic collection

and library has been completed. 23 new experimental plot files were opened and 20 were closed, final summaries being posted in the appropriate ledger files.

In consultation with territorial officers a number of type areas and individual trees and groups of trees of special interest have been listed. Demarcation of these areas and writing up of records has not yet been done.

The District Forest Officer, North Salem, has worked in collaboration with the Indian Institute of Science and the Forest Entomologist in connection with their investigation into spike disease of sandalwood.

NORTH-WEST FRONTIER PROVINCE.

I.—Experimental Silviculture.

(1) *General.*

Due to failure of natural regeneration of blue pine efforts were made to find out the best method and species for re-stocking the forests artificially.

Deodar and walnut were tried on a large scale, but the former suffered badly from an exceptionally severe and prolonged drought. The latter, however, is doing very well in depressions, particularly where it has been protected from rats by growing in cylinders of wire mesh netting. Experience has shown that these cylinders need not be 4″ in diameter but may even be less, which will reduce the cost by over twenty-five rupees per acre; cylinders of cheaper material are also being tried with quite encouraging results.

(2) *Natural Regeneration.*

A fire passed over one of the experimental plots which were laid out to find the optimum intensity of blue pine regeneration fellings combined with the presence and absence of grazing; only one plot (where grazing was prohibited) escaped. Consequently no comparison is possible and the experiment will have to be repeated.

The experiments with regard to effect of weeds on young regeneration of blue pine, mentioned in the last year's report have conclusively shown that they are very beneficial for protection against hot sun and are now discontinued.

With a view to finding out the correct intensity of seeding fellings, two sample plots have been laid out in blue pine forest of Pattan reserve, leaving 14 and 20 trees per acre.

Chil (*Pinus longifolia*) continues to reproduce well. It is conclusively proved that complete regeneration of *chil* is impossible under continuous grazing.

The following table gives the result of counting mortality percentage of natural blue pine and artificially raised deodar seedlings in experimental plots :—

Regeneration.

—	1st counting.	2nd counting.	3rd counting. (4-5-32)	4th counting. (30-6-32)	5th counting. (25-5-33)	6th counting.
Panjul 12 (*iii*) Plot No. 1 (partly shaded) Blue pine natural.	226	210	88	80	15	..
Plot No. 2 (wholly exposed) Blue pine natural.	260	230	32	27	1	..
Panjul 11 (*i*)—						
Plot No. 3 Deodar artificial	34	34	..	..	31 (3rd counting)	..
Plot No. 4 Deodar artificial	200	200	..	..	192 (3rd counting)	..
Daddar 2 (*iii*)—						
Plot No. 1 Blue pine natural	290	287	206 (13-4-32)	158 (8-9-32)	131 (9-12-32)	103 (19-4-33)
Plot No. 2 (comparatively exposed) Blue pine natural.	61	61	59 (13-4-32)	12 (8-9-32)	10 (9-12-32)	7 (19-4-33)

The figures are interesting as we have reached a stage when conclusions can be drawn with a reasonable amount of accuracy.

(*a*) It is obvious that both in case of natural and artificial blue pine regeneration the mortality is very much higher in exposed plots.

(*b*) It is proved that drought is the main factor responsible for mortality, the season of the year at which it occurs being secondary. Thus there were comparatively few casualties during a relatively wet September and October 1931, as compared with a dry April and early May 1932 ; and again high mortality during a dry September and October 1932 and relatively low in a wet April and May 1933. These figures are instructive ; the occurrence of drought is not capable of control, therefore overhead shade in the only way of mitigating its effects. Its importance is emphasised by the fact that in both the exposed plots (natural and artificial) we are now left with one and seven seedlings respectively as compared with 55 and 103 in the case of shaded plots. The results of the experiments on the intensity of marking in blue pine regeneration areas are apparent. More than one crown breadth between the standards is not called for ; the retention of hardwoods wherever they can give light shade to the young blue pine seedlings is also indicated. These experiments are of considerable importance and will be repeated again on a larger scale to verify the results already obtained.

As regards deodar artificial regeneration countings were started when the seedlings were already of more than a season's growth and in both cases the sample plots have a requisite degree of shade. Under these conditions they show satisfactory persistence.

(3) *Seed.*

Owing to deficiency of deodar seed in Kulu and Kashmir, local seed was collected and tried, but the local seed year was bad and the result demonstrates the inadvisability of using inferior seed.

(4) *Nursery Work.*

Several new nurseries were started in Lehri, Thandiani, Dungagali, Barian, etc. The wire mesh netting has afforded efficient protection against outside rats, but it is necessary to kill or keep down the rats which may have been left inside the fence or may have entered under the snow; " Cynogas " is used frequently. Ash has been successfully raised in a nursery in Panjul 11 (i) and a considerable number of seedling have now been transplanted in the forests in suitable localities. 50 per cent of these have now established themselves. Ash grows naturally in Una compartments of Upper Siran range. As the timber is valuable and a ready market would be obtainable if sufficient were forthcoming, the technique of raising it in a nursery is briefly given below :—

Ash can be raised successfully in areas where it occurs naturally, but any attempt to force it in unsuitable localities in Hazara or the Punjab without a study of the locality factors is doomed to failure. It grows mostly at an elevation of between 8,000 and 9,500 feet in Upper Siran, prefers a northerly aspect at lower elevations and occurs without any preference as to aspect at the higher elevations of its zone; it is usually found in depressions and along the banks of nallas. Sowing in the nurseries should be done in lines in the third week of December, the soil having been freshly prepared. Germination commences in 15 months, *i.e.*, in the spring of the second year and the germination percentage should be high. The crucial point found out by experiment was that *no weeding should be done till the middle of July* even though the growth of weeds is considerable; otherwise the seedlings perish due to exposure, and many of the small seedlings are uprooted however carefully the weeding may be done. Transplanting should be done during the rainy season in the same year.

(5) *Artificial Regeneration.*

Several methods of introducing deodar and walnut were tried. Deodar seed was shown in burnt patches alone and mixed with *Indigofera Belladona* and *Paeonia* seed to provide shade, but these shade givers have

failed. Walnut was sown and planted, both entire seedlings and root and shoot cuttings, but it has given good results only where protected from rats by wire cylinders. Deodar and blue pine plants have suffered greatly from drought, while cut-worms have damaged germinating seedlings.

(11) *Miscellaneous.*

The experiment of burning of *chil* forest annually in preference to biennially or triennially and the effect on vegetation was continued. As a result of the observations during the current year, it is now established beyond doubt that the ground flora goes on progressively decreasing from year to year although the decrease is not startling. There seems however no doubt that at the end of a 7-year cycle it will be appreciably less than at the start of the experiment. Efforts were made this year to discover whether the decrease is due entirely to the proportional decrease in moisture percentage or whether other factors come into play. It is conceivable that many shrubs and herbs whose seeds are shed in autumn (germinating in the next spring) are destroyed year after year by the burning. Further the rhizomes of many annuals are affected by burning and though not completely destroyed, nevertheless send up feeble shoots. There is no doubt that these are contributory factors though loss of moisture is the main one. The decrease of soil cover means less utilisation of the moisture from the superficial layers of the soil by these shrubs and herbs, but such superficial moisture is of little use to the trees, only a very small percentage of it sinking into the deeper layers and the rest evaporating through lack of soil cover. It may now be said definitely that there is no hostility on the part of villagers towards annual burning.

Experimental burning of *chil*, in Periodic Block I areas in Batrassi was carried out on a large scale this year with the Chief Conservator of Forests' approval and it is hoped that almost all the saplings will recover. It is too early to draw any definite conclusion, but in most cases the needles have merely been singed.

II.—Working Plans and Statistics.

A revised working plan for the Kagan Valley forests and a plan for Swat Kohistan forests were published. The former has been sanctioned by the local Government, while sanction for the latter is still awaited.

PUNJAB.

I.—Experimental Silviculture.

(1) *General.*

Mr. H. G. Champion, Silviculturist, Forest Research Institute, toured in Kulu division in May-June 1932 for about 4 weeks inspecting with the

Provincial Silviculturist all the nursery and forest experiments discussing with him and demonstrating methods of the lay-out of indicator plots and the assessment of regeneration. His advice on the spot and suggestions contained in a comprehensive inspection note have been of great value.

(2) *Natural Regeneration.*

(i) *Spruce* (*Picea morinda*) *and silver fir* (*Abies pindrow*).—1932 was a good seed year for both spruce and silver fir and studies in their natural regeneration in several experimental plots laid out last year in Kulu and Lower Bashahr have now begun. Lala Parma Nand Suri, Provincial Silviculturist, presented a preliminary paper on " A study in the ecology and silviculture of the Himalayan spruce and silver fir with special reference to works in progress in Kulu " to the Punjab Forest Conference, 1933.

(ii) *Chil* (*Pinus longifolia*).—Mr. N. P. Mohan, Deputy Conservator of Forests, presented a paper on " Ecology of *Pinus longifolia* with particular reference to Kangra and Hoshiarpur forest divisions " to the Punjab Forest Conference, 1933.

(iii) *Farash* (*Tamarix articulata*).—A peper on the " Cultivation of *farash* " read at the Punjab Forest Conference, 1933, by Messrs. Parma Nand Suri and Ram Saran Chopra, summarises results of study so far made regarding flowering, fruiting and seeding of *farash*, and its natural regeneration and propagation from seed and shoot cuttings.

(iv) *Bahan* (*Populus euphratica*).—A study in the time of flowering, fruiting and seeding of the poplar, its natural regeneration from seed, coppice and pollard shoots and root suckers and its propagation from seed and shoot cuttings is in progress. Capsules appear towards the end of February but ripe seed is available towards the close of August when capsules begin to open. The tree is a prolific seeder but seed does not stand storage and must be sown immediately. Its natural regeneration from seed appears profusely every year on new alluvium and moist ground, but it is either washed away or trampled down by cattle before it can establish itself. It does not coppice well but regenerates easily and completely from root suckers ; it also pollards satisfactorily.

(v) *Kahu* (*Olea cuspidata*).—The effect of cutting back *sanatha* (*Dodonaea viscosa*) over natural olive seedlings is being studied in Kalachitta. Exposure and bruising of its roots have not induced root suckers and the experiment seems to suggest that this species does not send out root suckers readily.

(vi) *Kalesar clearfelling experiment.*—In 20 acres clear—felled area in Kalesar, compartment 14, most of the young *sal* coppice shoots and seedlings that came up after clear cutting and burning are now beyond

the reach of *sambhur* and spotted deer; they have also escaped early and late frost so far.

(vii) *Dendrocalamus strictus.*—The profuse natural regeneration of bamboo from seed from flowered clumps in the Bindraban and Karnpur forests (Hoshiarpur) reported last year has practically disappeared on account of the forests being open to grazing for 9 months during the year when the un-established palatable seedlings are readily eaten by cattle.

(3) *Seeds.*

(i) *Seed year and seed indents.*—1932 was a good seed year for spruce and silver fir; the seed crop failed for deodar and was moderate for *kail* and *chil.* Seeds were exchanged with foreign forest research stations.

(ii) *Seed weighments.*—Routine seed weighments of 24 species were carried out and figures for those yet un-recorded or recorded on the basis of few weighments, are given below :—

Species.	Origin of seed.	Date of collection.	Date of weighments.	No. of weighments.	Average No. of seeds per oz.	Remarks.
1	2	3	4	5	6	7
Abies pindrow .	Kulu division	Oct. 1932 .	31st March 1933.	4	774	
Acacia modesta .	Rawalpindi range.	14th Jan. 1932.	11th July 1932.	10	600	
Acer pictum .	Kulu division	..	31st March 1933.	4	225*	*Wings removed.
Alnus nitida .	Hurla range (Kulu).	Dec. 1932 .	11th April 1933.	4	27,322	
Azadirachta indica (syn. *Melia indica*).	Lahore divn.	July 1932	11th Aug. 1932.	6	56*	*Fruits with pulp.
Capparis aphylla .	Montgomery division (Arifwala).	25th June 1932.	3rd Sept. 1932.	6	38†	†Fruits : 13 seeds per fruit, average of 20 fruits.
Cedrela serrata .	Kulu (Parbatti Valley).	Dec. 1932 .	31st March 1933.	4	2,539	
Fraxinus micrantha	Kulu division	Nov. 1931	31st March 1933.	4	205	With scales.
Morus alba .	Changa Manga (Lahore division).	May 1932 .	14th July 1932.	9	12,908	
Olea cuspidata .	Rawalpindi range.	14th Jan. 1932.	11th July 1932.	10	165	
Picea morinda .	Kulu division	Oct. 1932 .	31st March 1933.	4	1,895	
Pinus excelsa .	Kulu division	Oct. 1932 .	31st March 1933.	4	720	
Prosopis glandulosa	Lahore division	May 1932 .	11th Aug. 1932.	6	12‡ (pods)	‡194 pods per lb. 15 seed per pod.
Populus euphratica Jhok.	Lahore division	Aug. 1932 .	11th Aug. 1932.	6	862§	§Capsules contained on an average 17 seeds.
Prosopis spicigera .	Multan division	Aug. 1931 .	May 1932 .	8	770	
Tamarix articulata	Lahore division	27th July 1932.	16th Sept. 1932.	10	13,650	Each weighment of 5 grams.

(iii) *Germination tests.*—The 1931 deodar seed (a good seed year) gave germination and plant percentages of 65 and 58, respectively, while the 1930-31 *kail* seed gave germination percentages of 60 and 43 and plant percentages of 42 and 38 respectively. In the case of 1930 *kail* seed 21·2 per cent mortality occurred during the germination period, out of which 9·8 per cent was caused by drought and 11·4 per cent by cut-worms. October 1931 spruce and silver fir seeds (a poor seed year) have given very low germination and plant percentages; 20 and 14 per cent for spruce and 13 and 6 for silver fir. *Ash* (*Fraxinus micrantha*) seed sown with and without scale commenced to germinate after 16 months. Removal of scale did not hasten germination. The seed is now being subjected to various chemical and mechanical treatments to see if it is possible to accelerate germination.

Summaries of results obtained with germination, plant percentage and seed treatment tests carried out at Lahore and Chichawatni with a few species of importance in the Punjab plains, are given below :—

(*a*) *Acacia catechu* (*khair*).—The species does not germinate at all in *kallar* soil and very poorly in manured soil. It germinates best in clayey loam and better in shade than in the open. The highest germination percentage (82) is obtained with seed soaked in boiling water till it cools down and then dried in shade and sown in leaf-mould under cover; soaking the seed in boiling water until it cools down is found to be the best treatment. Plant percentage is, however, as low as 20, casualties being mostly due to white ants and frost; growth is slow, 3 months old seedlings being not more than 3″ high.

(*b*) *Acacia modesta* (*phulai*).—(i) The species does not germinate at all in *kallar* soils. Light soils are very suitable for its germination, leaf-mould being the best and garden soil (a mixture of canal silt, leaf-mould and cow dung in 3 : 2 : 1 ratio) the next best. (ii) Sowing under shade is preferable to sowing in the open; it slightly hastens germination, reduces considerably the germination period and gives much higher germination per cent. (iii) The best seed treatment for sowing in the open is soaking in cold water for 12 hours; while in the shade soaking in boiling water until it cools down gives the highest germination percentage; the next best treatment is soaking in cold water for 24 hours. In Rawalpindi West division soaking in water at ordinary temperature for 72 hours followed by exposure to the sun has given 92 per cent germination against seed treated with 1 per cent solution of sulphuric acid ($H_2 SO_4$) and potash lye (KOH) for an hour with only 25 and 16 per cent germination respectively. Plant percentage is very low (only 14) due to white ants, and growth is slow.

(*c*) *Butea frondosa* (*dhak*).—The species is very easy to raise from seed. Pod segments or seeds separated from pods soaked in cold water

for 12 hours give almost cent per cent germination. The species germinates better in moderately heavy soils (garden soil) than in heavy soils (clayey loam). Though frost and drought tender, the plant percentage is very high,—86 per cent.

(*d*) *Capparis aphylla* (*karir*).—(i) Soaking the fruit in cold water for 12 hours and 48 hours gives best germination in shade and in the open respectively. In case of seed taken out of the fruit, soaking in cold water for 24 hours gives best germination. (ii) Seeds taken out of fruit give a higher germination percentage than fruits, but on an average only about 40 per cent seeds in a fruit are sound, and in view of the labour involved in extracting seed from the pulpy fruit and its low survival percentage, it is better to sow the fruit. (iii) *Plant percentage.* For plants in groups (groups of plants originating from each fruit) percentage was 35 and plant percentage (on the basis of 13 seeds per fruit) only of 5, casualties being due to white ants. It is, however, interesting to note that a few of the remaining fruits germinate in the next growing season.

(*e*) *Olea cuspidata* (*kahu*).—(i) Untreated olive seed takes a long time to germinate, ordinarily about 3-4 weeks. Clipping off the seed apex starts germination in 12 days, but clipped seed is liable to be eaten by ants. Soaking the seed for 12 hours in 5 to 15 per cent caustic soda or sulphuric acid or in boiling water, or breaking the endocarp, are the next best treatments in this respect. (ii) Period of germination varies from 20-52 days, being lowest (20 days) for seed soaked for 12 hours in 10 per cent sulphuric acid solution. Germination in the case of untreated seed takes on an average for 34 days. (iii) Germination is generally poor. The best results are obtained with seed soaked for 12 hours in 5 per cent caustic soda solution (*i.e.*, 64 per cent) the next best being for seed soaked for 12 hours in 5-10 per cent sulphuric acid solution (48 per cent), against an average germination of only 14 per cent with untreated seed. (iv) Soaking the seed for 24 hours in 5 to 15 per cent caustic soda solution is harmful to the extent of killing it (*nil* to 1 per cent results). (v) Immersion for 12 hours in 5 per cent caustic soda or 5-10 per cent sulphuric acid solutions, gives the best results, *i.e.*, both for commencement, period, and percentage of germination. (vi) Good and bad seed can be sorted out to some extent by immersion in 10 per cent brine solution : good seed sinks down, bad seed floats. (vii) Germination is much better under shade than in the open (10 to 64 per cent against 1 to 15 per cent).

(*f*) *Prosopis glandulosa.*—To raise it artificially two treatments have been recommended in the past (i) to use seed from droppings of sheep and goats, (ii) to dry the pods,separate the seed and soak it in boiling water for a night. The pod is indehiscent and has a sticky inner lining which makes it difficult and laborious to clean the seed for sowings on a

large scale. Results of experiments on various seed treatments and soil media carried out in 1931 and 1932 are that (i) it does not tolerate *kallar* soil but it germinates equally well both in heavy (clayey loam) and light (leaf-mould) soils, both in shade as well in the open, though slightly better results are obtained under shade; (ii) seed removed from pods germinates quicker and gives a higher germination percentage but in view of practical difficulty in cleaning the seed, soaking the pods for 48 hours in cold water is quite a satisfactory method.

(iv) *Miscellaneous seed experiments.*—(*a*) *Effect of elevation on size and colour of kail seed.*—1932 *kail* seed collected at different elevations in the Parbatti valley, Kulu division, confirms last year's observations, *i.e.*, seed collected at about 7,000′ is the biggest and best developed, seed of 9,000′ elevation is shining light gold to reddish brown and seed of 5,000′ and 7,000′ is of dull blackish brown colour. Average number of seeds per oz. for different elevations is as under :—

Salasgahr	(5,000′)	780
Kalga	(7,000′)	566
Swajni	(9,000′)	621

(*b*) *Effect of elevation on germination and plant percentage and seedling development of kail.*—This experiment is continuing. Results so far obtained show that seed from all the 3 altitudes (5,000, 7,000 and 9,000′) germinates best at 5,000′ but plant percentage is highest at 7,000′. Seed collected at 9,000′ has given best germination and plant percentage, that of 7,000′ closely following it, but there is no indication at present that seed of a particular elevation does best only at that elevation. Plants are now being transplanted to study their development at the 3 altitudes.

(*c*) *Effect of elevation on germination and survival percentage and development of deodar seedlings.*—Deodar seed collected from 5,000′—7,000′ and 7,000′—9,000′ in the dry zone of Kagan, Hazara, was sown in an experimental nursery at Monali (6,200′, rainfall 44″). Seed from 7,000′—9,000′ has given higher germination and plant percentages and better seedling development, due probably to this range of elevation being the optimum for deodar in the dry zone. Plants are being transplanted in the forest to study their further development.

(*d*) *Effect of locality on germination and plant percentage and seedling development.*—This is being studied with deodar seed collected from (1) Upper Bashahr (dry zone), (2) Upper Bashahr (wet zone), (3) Lower Bashahr (wet zone) and (4) Inner Seraj (wet zone) and sown in experi-

mental nurseries at Monali. There is at present little obvious difference in the development of seedlings of the above origins. Measurements of root and shoot lengths of a few seedlings of Upper Bashahr dry and wet zone however show a marked difference: length of root is 2·08″ in the dry zone and 1·61″ in the wet zone for every inch of the shoot. The longer tap root development in the case of dry zone seedlings is probably an adaptation to scarcity of moisture which they have normally to face. Plants raised from seeds of different origin are being transplanted in the forest where their habits, form and growth will be studied.

(*e*) *Effect of the size of trees on germination, plant percentage and seedling development.*—This was studied with deodar and *kail* with the following results :—

Cedrus deodara.—(i) 8″-12″ diameter class trees yield fertile seed with a fairly highly germinating capacity. (ii) 12″-16″ diameter class trees give the best germination and plant percentages; the 28″-32″, 32″-36″ and 16″-24″ diameter classes being the next best. The lowest germinating capacity of seed from trees 24″-28″ diameter is inexplicable (c.f. *kail*) (iii) 16″-24″ diameter class tree seeds give the largest number of best developed seedlings, that from 12″-16″ closely following. (iv) The best results are obtained with seed collected from 16″-24″ diameter class trees. (v) No direct correlation exists between size of trees and germination and plant percentage.

Pinus excelsa.—(i) A fair percentage of seed collected from trees of lower diameter classes (below 20″) is fertile. (ii) Seed from trees of 28″-32″ diameter gives the highest germination and plant percentage, 20″-24″ diameter trees closely following it. (iii) Seed from 24″-28″ diameter class trees gives the lowest germination and plant percentage which is inexplicable (c.f. deodar). (iv) No direct correlation exists between size of trees and germination and plant percentage.

(*f*) *Effect of the general condition of trees on gernination, plant percentage and development of seedlings.*—Deodar seed collected from (*a*) top dry over-mature trees over 60″ in diameter, (*b*) top flat over mature trees 44″—56″ in diameter and (*c*) sound mature trees 28″—32″ in diameter was sown in experimental nurseries at Monali. Seed from sound mature trees 28″—32″ in diameter has given the best germination and plant percentages and also the largest number of well developed seedlings.

(*g*) *Effect of the size of seed on germination, plant percentage and development.*—Horsechestnut seed was sorted in two sizes (1) 1½″ and over and (2) under 1½″ in diameter and sown in experimental nursery at Monali. Decidedly better germination, plant percentage and development of seedlings were obtained with bigger seed.

(*h*) *Seed storage.*—It has been found by experiment that deodar seed does not stand storage even for 1 year and so must be sown before snowfall following collection, and failing that immediately after snow has melted while it still retains its germinating capacity.

(4) *Nursery Work.*

The experimental research nursery at Monali was extended. A large experimental nursery with separate blocks of raised and shallow beds was started at Chichawatni.

(*a*) *Nursery transplanting spacing experiments. Cedrus deodara.*—December 1930 deodar seedlings were pricked out in nursery lines in July 1931, spaced 3″×3″, 6″×6″ and 9″×9″ with control beds of unpricked seedlings about 1″ apart in lines 6″ apart. Results as regards average and maximum height growth and the percentage number of well developed plants clearly demonstrate the advantages of pricking out in nursery lines and the superiority of adopting 6″×6″ spacing. Considering however the nursery space and expense it would be sufficient if seedlings are pricked out 3″×3″—this spacing gives a much larger number of almost equally well developed transplants over the same nursery area.

(*b*) *Weeding experiments.*—In the case of spruce fir, survival percentage was 81 in weeded beds against 46 per cent in control beds; the development of the weeded seedlings was also better. Experiments with mulberry have given similar results.

(*c*) *Transplanting in nursery beds.*—6 months old deodar forest seedlings were pricked out in nursery lines with 81 per cent survival.

(*d*) *Nursery shades.*—Mulberry was experimentally raised from seed in nursery beds in the open, under light cover of tree shade, under 66 per cent shade of *kana chiks* and under complete shade of palm leaf mats. Light tree cover and 66 per cent shade have given the best results.

(*e*) *Populus ciliata.*—Seed collected in July-August and sown in Monali nursery beds has given profuse germination. Natural seed blown from neighbouring trees also germinated in abundance everywhere in prepared nursery beds and has to be uprooted.

(*f*) *Cupressus torulosa.*—Cypress has been successfully raised in the Parbatti range, Kulu division; local seed was sown in July 1932 in nursery beds containing soil brought from under cypress trees and lime *bajri*. In view of its very low germination percentage, very dense sowings should be made.

(*g*) *Larix europœa* and *Larix griffithii* have been successfully raised in experimental nurseries at Monali, Kaisdhar and Pulga (Kulu); several other exotics are also being raised.

(5) *Artificial Regeneration.*

Direct sowing and planting of silver fir, spruce, deodar and *kail* are being tried in clear felled experimental plots in Kulu (Nos. 30 and 40). Both spruce and silver fir sowings have so far failed due to looseness of soil and heavy weed growth especially *Strobilanthes*. Deodar and *kail* sowings have, however, partially succeeded, the former especially where protected against eastern sun. Planting of all the 4 species has given very encouraging results and seems preferable to direct sowings in clear felled areas especially when they have to be stocked with spruce and silver fir. Winter planting seems to be successful only in very favourable weather.

Acacia arabica (*kikar*) was sown broadcast in Sohni forest (Muzaffargarh, Multan division). Germination was good, but most of it was killed by frost. In Bindraban reserved forest compartment: 7, Hoshiarpur division, 225 one-year-old nursery raised *kikar* seedlings were transplanted with success.

Robinia pseud-acacia root cuttings planted in Jutogh nursery (Simla division) every month from August 1932 to March 1933 have invariably failed.

Dendrocalamus strictus.—Bamboo sowings made in Hoshiarpur division and in previously prepared (hoed up) patches along the *nalas* have given good results. In the same division, 880 one-year-old nursery raised bamboo seedlings have been successfully transplanted in Bindraban, compartment: 7. Bamboo seedlings put out in Dhamtal reserve, Kangra division, and in Khanewal plantation, have, however, not done well.

Ischæmum angustifolium (*bhabar*) *grass.*—7 experimental plots were started during the year in Kalesar reserved forest.

Tube planting.—Deodar, *kail, chir*, spruce and silver fir have been successfully raised in 6—8″ long and 2″ diameter open tubes of galvanized iron and lead sheet. Tube plants are being transplanted in the forest during the rains. Coal-tarred paper tubes closed at one end have not proved successful: they rot before the plants are sufficiently large to go to the forest.

A few *Eucalyptus* seedlings raised in bamboo tubes have been planted with tubes and they are growing well. Bamboo tubes, however, take long to rot and thus interfere with the root development of the plants. *Eucalyptus* seedlings have been raised in small split reed tubes which are now being planted in the forest.

(6) *Reclamation and Afforestation.*

Irrigated Plantations.—Morus alba.—Mulberry has been successfully raised in virgin soils without overhead tree cover by stump planting

Patch sowings along the berms of trenches entirely failed. The weeds and grasses which were heavy had to be lightly thinned at the end of October to uncover mulberry shoots. In Khanewal plantation, mulberry stumps have been successfully planted under 2-year-old good *shisham* crops and also under 6—12-year-old poor *shisham* crops.

Eucalyptus.—Pot planting of *Eucalyptus rostrata* on the lines of a note on the subject by Khan Fazal Mohammad Khan published in *The Indian Forester* for April 1932 was continued both in Changa Manga plantation and Pakhowal water-logged area with great success. Experimental pot planting of *Eucalyptus citriodora, Eucalyptus crebra, Eucalyptus tereticornis* and *Eucalyptus glauca* was also tried in Changa Manga; all failed except *Eucalyptus tereticornis* which gave 66 per cent success.

Other species.—Ber (*Zizyphus jujuba*), *dhak* (*Butea frondosa*), *khair* (*Acacia catechu*), *Acacia senegal* and *Acacia leucophlœa* as substitutes for *shisham* (*Dalbergia sissoo*) have been given up, as some are thorny and others frost tender. Moreover their water requirements do not seem to be any less than *shisham.* Where *shisham* does not flourish, *farash* (*Tamarix articulata*) is being raised from shoot cuttings. To study the possibility of introducing *Rhus viminalis* in Khanewal, its seed was sown along trenches and in bottomless pots. Germination was better in pots (70 per cent against 20 per cent) and some plants have grown 3′ in 8 months.

(8) *Mixtures.*

Shisham (*Dalbergia sissoo*) and *farash* (*Tamarix articulata*) mixture by lines is reported to have given good results in Khanewal plantation.

(11) *Miscellaneous* (*Burning, Poisoning, etc.*)

Controlled burning in chil seedlings and sapling crops.—Results of experiments carried out in Rawalpindi East division by K. A. Allah Bakhsh have been published in an article " Control Measures for the Protection of the Regeneration of *Pinus longifolia* " in *The Indian Forester* for June 1932.

Lantana camara.—On account of heavy cost, no further work on the eradication of *Lantana* was carried out in Kangra division. The pest has not yet invaded any valuable forests, and outside it seems that *Lantana* is replacing shrubs which have been badly browsed and killed by goats and as such it is perhaps a blessing in disguise because sheep and goats do not touch it.

II.—Working Plans and Statistics.

(1) *Working Plans.*

Working plans for the following areas were sanctioned :—

(1) Upper Bashahr division.

(2) Kangra division.

(3) Chichawatni plantation.

(4) Goler, Dada Siba, Kutlehr and Nadaun jagirs.

(5) Rawin and Dhadi states.

Working schemes for forests in the following areas were prepared in Simla division and sanctioned by the Chief Conservator of Forests :—

(1) Mailog state.

(2) Madhan state.

(3) Sabathu cantonment.

(4) Dagshai cantonment.

(5) Kasauli cantonment.

Working plans and schemes are under preparation for :—

(1) Hoshiarpur division.

(2) Kulu and Seraj divisions.

(3) Khanewal plantation.

(4) Keonthal state.

(5) Dalhousie municipality.

(2) *Yield Tables.*

The provincial sample plot party laid out 22 new plots and remeasured 44 old plots including 12 in Hazara (North-West Frontier Province). The total number of existing permanent sample plots now stands at 189.

(3) *Volume Tables, etc.*

A number of trees were measured for standard and commercial volumes, etc., and firewood conversion factors were worked out for hard and soft woods sold in Murree hills.

III.—Miscellaneous.

Three plots, 1 of mature and over-mature firs and 2 of indigenous dry *rakhs*, and a few individual specimen trees (deodar, olive and exotics) were preserved during the year. Specific and general ledger files now number 103 and 263, respectively. The library was maintained and the photographic collection now contains 1,300 photographs and 109 lantern slides.

UNITED PROVINCES.

I.—Experimental Silviculture.

(1) *General.*

The reorganisation of experimental research which was commenced two or three years ago is now practically complete. As mentioned in last year's report Divisional Forest Officers carry out stage II investigations and the Silviculturist stage I, but since the Silviculturist cannot carry on work in all the divisions in the province it is still necessary for some Divisional Forest Officers to carry out stage I experiments in some divisions. The total number of sanctioned silvicultural experiments in the province is 103, *i.e.*, 65 under the Silviculturist and 38 under the Divisional Forest Officers.

A new research programme and new lists of experiments carried out by the Divisional Forest Officers and by the Silviculturist were printed and issued. Also instructions regarding experiments and annual silvicultural report were revised and amplified and have been reprinted. The procedure to be adopted in respect of research experiments is now clearly laid down and all possibilities of confusion will, it is hoped, be avoided in future.

An All-India enquiry in *sal* problems was carried out during the year; the Central Silviculturist visited Haldwani, North Kheri and Gorakhpur divisions, and representatives from the United Provinces visited Bengal and Central Provinces.

(2) *Natural Regeneration.*

Sal (*Shorea robusta*).—(*a*) *From seed.*—This item naturally continues to attract considerable attention and absorbs a large share of the research activities of the Province. The problem divides naturally into two parts :—

A. How to obtain adequate seedling regeneration on a large scale when and where we wish and how to develop it to the whippy stage.

B. How to develop the whippy stage to the sapling crop.

As regards A there is still a great deal of experimental research to be done. We now recognise certain areas of dry type of *sal* forest (dry alluvial type) where the ecological conditions preclude any reasonable expectation of natural *sal* regeneration, *e.g.*, parts of Saharanpur, Jaspur, Motipur. In such areas further research on natural regeneration has been stopped and instead experiments have been laid out to explore the possibilities of artificial (*taungya*) regeneration or to explore a change of species of economic value and better suited to the dry conditions.

There are further important areas (the moist high level alluvial type) where a solution of the problem of natural regeneration seems possible, if not probable, and the Silviculturist has been actively engaged during the year in laying out a series of experiments in this type (Haldwani and Ramnagar divisions), which will, it is hoped, in time throw considerable light on the problem. These experiments explore various combinations and permutations of four important factors :—

(1) Canopy and overwood.

(2) Burning.

(3) Deer damage.

(4) Competing weeds.

Several years will necessarily elapse before conclusive results are obtained.

In this connection the Divisional Forest Officer, Gonda, records an interesting experiment carried out over one acre, where there were abundant natural *sal* seedlings of the 1929 seed year. The area was clear-felled and kept thoroughly weeded in the rains of 1930. It is reported that the area is now covered with *sal* seedlings approaching the whippy stage, and the Conservator of Forests, Eastern Circle, has ordered an extension of this experiment to five acres. (This conforms with the experiments carried out by Hole as Forest Botanist and more recent work in Bengal.)

Experiments to induce new regeneration in the damp type of *sal* forest in North Kheri and elsewhere by frequent controlled burning under a fairly complete canopy have not been successful and have now been largely discontinued. It is reported that the controlled burning resulted in considerable reduction of *rohini* (*Mallotus philippinensis*) evergreen undergrowth and climbers, but subsequently there was an increase of *Clerodendron*, and no appreciable increase of *sal* regeneration. Whether controlled burning combined with heavy felling as advocated by some Assam foresters will be more successful it is impossible at present to say, but this will be tested on an adequate scale in the Silvilculturists' experiments.

As regards B we are beginning to obtain some interesting and instructive results from experiments laid out from time to time during the last four or five years in a number of different divisions to test the influence of deer-proof fences, manipulation of canopy, and competing weeds.

The advantages and limitations of deer fences are becoming more clearly realised and established and the accumulating evidence tends to suggest as follows :—

(i) There is no evidence yet that deer fences will induce new seedling regeneration. Their beneficial action appears to begin to

function only where there are ample whippy and small woody plants to protect (Bahraich and Pilibhit).

(ii) Deer fences are most beneficial combined with light overwood. With heavy overwood their beneficial effect is much less marked or altogether negligible. Divisional Forest Officers, Bahraich, North Kheri and Haldwani all stress this important point, in fact Divisional Forest Officers, North Kheri and Bahraich, lay even more emphasis on the heavy felling of overwood than on the deer fences. Ramnagar division also shows remarkable examples of stimulation of small coppice growth under light overwood or no overwood at all, even after years of deer-browsing had reduced the *sal* regeneration to a parlous and miserable state.

(iii) Ample light and deer-proof fences also stimulate growth of competing weeds. Divisional Forest Officers, Haldwani and Bahraich record beneficial results to help *sal* by shrub-cutting. This is also borne out in the Ramnagar fenced areas. No final conclusion can yet be made and experiments are being continued but the present evidence does support the opinion that a combination of deer fences, light overhead canopy, and some cleaning or weeding, in areas already containing sufficient whippy or small woody shoots, gives the best promise of success.

Sal (*Shorea robusta*).—(*b*) *From coppice.*—Experimental research on *sal* coppice regeneration is not so extensive as on seedling regeneration, as there is less scope for research. Coppice regeneration is usually successful unless (as in Tikri) the old stools are worn out and can no longer coppice, when they are replaced by *taungya* seedlings, or unless there is some fairly obvious factor preventing coppice growing up, *e.g.*, excessive deer browsing as in Ramnagar or frost as in the Pilibhit and South Kheri *chandars*. The control of the deer factor is no longer in the experimental stage as deer fences have provided a satisfactory solution, especially in Ramnagar.

The problem of *sal* frost *chandars* still remains unsolved. Some elaborate large scale and extensive experiments were started in the year 1928 both in the Pilibhit and the South Kheri divisions in order to test the possibility of protecting *sal* shoots from frost by irrigation with canal water from the Sarda canal during the period when frost is liable to occur (middle of December to middle of February). In both cases the experiment has had to be given up as a failure, mainly because the supply of water from the canal proved very uncertain, for example a period of severe frost coincided with the Sarda canal being entirely dry with the result that the fairly promising results from previous irrigation

were destroyed in a night. It is also noted that the total expenditure inclusive of canal dues is likely to come to over Rs. 150-0-0 per acre, which is prohibitive.

Hill Conifers.—No silvicultural research is being carried out in the natural regneration of hill conifers. In the case of *chir* (*Pinus longifolia*) the only outstanding problem is administrative and not silvicultural, *i.e.*, to keep out fire for a limited-period of years when regeneration starts. In case of deodar (*Cedrus deodara*) regeneration is now mainly artificial. The only experiment being carried out is to test the possibilities of direct sowing with weeding as opposed to planting (Chakrata).

Other miscellaneous species.—Haldu (*Adina cordifolia*).—In many deer-fenced *sal* areas, especially when fenced after burning slash, we find vigorous natural *haldu* plants (Kalagarh, Haldwani, North Kheri). It appears that adequate *haldu* regeneration can be produced at will given two essential conditions :—

(*a*) Suitable germination bed, particularly wood ash.

(*b*) A deer-proof fence.

Hill oaks. (*Quercusin cana, dilatata, lanuginosa*).—*From coppice.*—Interesting results have been obtained from the Silviculturists' experiments laid out in 1928. The results may be briefly summarised as follows :—

Quercus incana.—The Bhowali plot (altitude 5,500 ft.) is decidedly promising and shows 60 per cent. of the stools surviving, with an average coppice height growth of 5 ft. in four years. A high level plot at Kilberry (altitude 7,000 ft.) shows only 40 per cent. survival and 3 ft. height of coppice.

Quercus dilatata.—Coppice growth is very poor, only 30 per cent. survival and 1½ ft. height of coppice.

Quercus lanuginosa.—Shows 60 per cent. survival and 3 ft. height of coppice in four years. These two species are in the Kilberry high level plot. The system of simple coppice for *Quercus incana* has been adopted in the Garhwal and West Almora working plans.

(3) *Seeds.*

The United Provinces Seed Store at Clutterbuckgunj continued to function as a distributing agency for seeds of all sorts especially teak. During the year 103 mds. of Burma teak and 26 mds. of Gorakhpur teak were distributed to Divisional Forest Officers and others. Germination tests of the entire stock of seed at Clutterbuckgunj were completed

in 1932 to investigate the viability after various periods of storage under the ordinary conditions. Seventy-eight tests were carried out in all and these germination tests are being repeated in 1933. The results obtained will be published in due course.

(4) *Nursery Work.*

At the close of the year various electrocultural experiments were commenced by the Silviculturist in his murseries to test the effect of treating seeds with X-rays, high tension sparks and electrolytic currents and to try Dr. Nehru's so-called " radio-magnetic " nets in nursery beds. The " radio-magnetic " jackets were also put round teak cut back after frost damage in the *taungya* area at Clutterbuckgunj.

(5) *Artificial Regeneration.*

(*a*) *Taungya.*—Every effort continues to be made throughout the province to extend *taungya* plantations and the enthusiasm of the territorial staff, particularly in the Western Circle, is leading to most promising and remarkable results. *Taungya* experiments find no place in most divisional research reports since they are regarded rather as administrative experiments than as silvicultural experiments. Actually they are frequently a combination both of administration and of silviculture, and it is proposed to call a *taungya* conference during the coming season in Naini Tal to try and co-ordinate results obtained in different divisions.

An interesting development during the year has been the introduction of departmental *taungya* where ordinary *basti* (villagers') *taungya* proved impossible, with cotton as a catch crop sown between *sal* lines, the revenue from which went a long way towards paying the total cost of the work. This interesting development gives promise of a useful weapon for tackling some of our difficult *sal* regeneration areas.

Taungya plantations are developing in three distinct types of forest land :—

(1) To regenerate mature *sal* crops where natural regeneration cannot be guaranteed.

(2) To replace low value miscellaneous forest by more valuable crops.

(3) To improve grazing grounds and for afforestation.

The Silviculturist is also employing *taungya* at Faridpur and Clutterbuckgunj to test the possibilities of " Fuel Next Door " schemes, *i.e.*, to grow quick-growing species such as *Dalbergia sissoo, Acacia catechu, Acacia arabica, Pongamia glabra,* etc., on *bhur* or soil too poor for culti-

vation, which will in time make fuel plots for the surrounding tenantry and thereby set free a certain amount of cow dung for manure for fields. Both the centres were severely affected by frost in January 1933, but it is reported that all plants have given out new shoots and are developing well.

(*b*) *Departmental.*—During the last two or three years the activity under this head has been appreciably reduced for the following reasons :—

(1) The considerable development of *taungya* has reduced the necessity for departmental operations. A concrete example is Jaspur range of the Ramnagar division.

(2) The operations which were experimental a few years ago have now passed out of the experimental stage.

These two factors are a very satisfactory development in the province.

(3) The financial crisis has necessitated curtailment of departmental operations which are not immediately remunerative.

A number of experiments are however still on the sanctioned list and their further development is being watched, although they are not being extended. The following may be mentioned :—

Sal.—The Silviculturist's experiment of sowing *sal* with *boga* (*Tephrosia candida*) in the Haldwani division, mentioned in the last year's report, continued to develop fairly satisfactorily, but severe drought between October 1931 and 21st of June, 1932, necessitated some resowing of *sal.* In many ways this experiment proved most useful,*e.g.*, it first established the necessity for a porcupine-roof fence with *sal* sowings, but the use of *boga* will in future probably be given up and replaced by cotton which is more valuable.

Teak.—The method of underplanting *sal* with teak cuttings has now passed the experimental stage. Experience in North Kheri, Bahraich and elsewhere has shown that removal of overwood should not be delayed more than three years after planting.* This is an important point which was rather lost sight of in Bahraich.

Semal (*Bombax malabaricum*).—A large scale experiment was carried out in the Haldwani division in Lalkua plantation of mixing semal with *Acacia catechu* in the sowings inside a porcupine-roof fence. The results were distinctly promising owing chiefly to the porcupine-roof fence combined with daily patrolling during the months of attack by porcupine *i.e.*, December and January. This daily patrolling was found essential as it appeared impossible to make any fence automatically porcupine-roof.

Miscellaneous species.—An interesting experiment to replace an inferior forest of the moist miscellaneous type by more valuable species,

which was commenced in the Dehra Dun division in 1930, has proved highly successful. Successful and well-stocked young crops of *khair* (*Acacia catechu*) and *sissoo* (*Dalbergia sissoo*) have been raised both with irrigated root and shoot cuttings and with irrigated and unirrigated *khair* sowings. The necessity for a deer-proof fence was clearly proved in this experiment. The experiment is now being closed.

Baib grass (*Ischæmum angustifolium*).—There is little to be added to the comments made on the experimental plantations of *baib* grass in the last year's research report. Conservator of Forests, Western Circle, very properly discourages experiments in *baib* grass in his circle on the ground that the available supply in his circle is already far in excess of the demand and tens of thousands of maunds of this grass are left to rot in the forests each year.

(6) *Reclamation and Afforestation.*

The work has been greatly curtained in the last year or two under this section. In the Afforestation division generally all large scale operations which are not likely to be remunerative have been stopped and further experiments and research in the Etawah ravine lands have been shut down.

The Silviculturist is still carrying out experiments on two types of waste land, *i.e.*, *usar* and *bhur*.

Usar (*Saline soil*).—The detailed experiment in the Unao district has not progressed far enough to warrant a report. In addition to weighments of grass obtained, a study of individual grasses is being made with the object of detecting changes in the distribution of species.

Bhur (*riverain sand*).—The Silviculturist's experiment at Ujhani in Badaun was kept under observation and a peculiar phenomenon was noted. Whereas in 1931-32 *sissoo* was badly affected by frost and *khair* was not affected at all, in 1932-33 frost badly affected the *khair* (some trees over 20′ high having been wholly or partially killed) and *sissoo* was scarcely affected at all. The Silviculturist has no suggestion to explain this contrary effect. The Kanjhera experiment on *bhur* was also affected both by frost and by drought, but it is noted that frost-affected plants have mostly given fresh shoots and many survive.

North Kheri phantas.—The experiment in the Sarota *phanta* (large grassy blank) started in 1930 to afforest *phanta* land by motor tractor cultivation with deer-proof fencing was not extended during the year under report, but past results were kept under observation. The Divisional Forest Officer reports that during the rainy season of 1932 very remarkable growth was put on and the results now appear to be far more promising than was originally anticipated. *Acacia catechu, Bombax* and bamboos appear to be the most promising species. The experience

gained in this experiment should prove very useful if in future financial conditions permit an extension of this type of work.

(11) *Miscellaneous.*

Resin tapping.—An elaborate series of resin tapping experiments in *chir* (*Pinus longifolia*) was laid out by the Silviculturist towards the close of the year and preparations for tapping were in full swing. The primary object is to ascertain whether depth of channel has any influence on the yield of resin. Altogether there are six experiments involving over 16,000 trees under tapping. It is intended that the experiments should continue for a full tapping cycle of five years, and the annual interim results should be of considerable interest. The Central Silviculturist who inspected these plots noted on the excellent lay-out of these experiments, which he considered was beyond anything hitherto attempted in India on these lines.

II.—Working Plans and Statistics.

(2) *Yield Tables.*

Sample plots.—The following permanent sample plots were measured during the year under report :—

Shorea robusta (*sal*).	*Dalbergia sissoo* (*shisham*).	*Cedrus deodara* (deodar).	*Pinus excelsa* (*kail*).	*Quercus incana* (*ban* oak).	*Acacia catechu* (*khair*).	Total.
24	14	31	5	2	2	78

No new sample plots were laid out during the year.

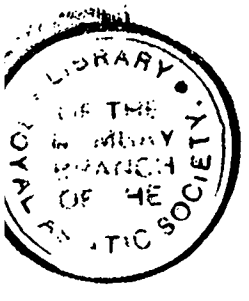
Hitherto statistical research from the time of Professor Troup until the present has concentrated chiefly on evenaged fully stocked crops. The increased importance of irregular *sal* forests of the selection type and the methods proposed in most recent working plans for safeguarding the yield of exploitable trees above the selection diameter, necessitate an early extension of statistical research to irregular types of *sal* forests. The best methods of carrying out this statistical research is under correspondence with the Silviculturist and the Central Silviculturist and it is hoped that a commencement will be made next working season in laying out some new sample plots. At the present time it is tentatively proposed that these sample plots of irregular forest will tend towards long linear strips comparable to the linear plots in Bengal rather than the usually compact rectangular sample plots utilised hitherto in evenaged forests. This new branch of statistical research will require very careful preliminary consideration.

III.—Miscellaneous.

Ledger filing.—A great deal of information was ledger-filed during the year. There still remains much to be done, particularly ledger filing of information in working plans and periodicals.

The Silviculturist was also busily occupied during the year in re-arranging the Central Forest Library in the Chief Conservator of Forests' office and preparing a new catalogue. It is hoped he will complete this work during the coming rains.

Publicity.—One lecture was given by the Silviculturist during the year. There were no additions to the United Provinces series of silvicultural bulletins published during the year, but several Forest Officers in the province contributed articles as usual to *The Indian Forester*. Amongst these may be mentioned an article on "Sal and its Regeneration in the United Provinces" by E. A. Smythies, which was awarded the Schlich memorial prize for the year.



CHAPTER III—FOREST BOTANY.

ASSAM.

Considerable progress has been made with the Flora of Assam. It has been practically completed up to *Apetalæ* (with the exception of the family *Euphorbiaceæ*). Difficulties with the printers have delayed publication, but it is expected that the first volume will be issued in the coming year.

Description of the following new species will soon be published complete with drawings:—

1. *Homalium bhamoense*, var. *Debbarmani*, Kanjilal (*Flacourtiaceae*), Garo Hills.
2. *Gymnocladus* nov. sp. (*Cæsalpinieae*) Khasi and Jaintia Hills.
3. *Eugenia* sp. (*Myrtaceae*), North Cachar Hills.
4. *Lagerstræmia* nov. sp. (*Lythraceae*), North East Frontier Tract.
5. *Maba* nov. sp. (*Ebenaceae*), Cachar.
6. *Symplocos pealii* (King m. s. s.) Das (*Styraceae*), Sibsagar, Lakhimpur.

The Silviculturist recently identified a timber tree of some importance, formerly classed as *sopa* (*Magnoliaceae*) in Lakhimpur as approximating to the new genus *Pachylarnax* of Mr. J. E. Dandy. The species is being fully described by Mr. Dandy and he intends to name the specimen *Pachylarnax pleiocarpa*.

Herbarium.—The local herbarium has now been arranged systematically. During the year 45 sheets have been added making a total of 20,000. Requisitions from the Cotton College, Gauhati, and other University Colleges have been received and they have been met as far as possible.

Miscellaneous.—Specimens and seeds of *Piper*, *Hoya*, *Vaccinium*, *Modecca* and *Coffea* have been supplied to institutions outside India through the Director, Royal Botanic Gardens, Kew.

A collection of grasses from the *sal* forests of Goalpara was made and identified in order to assist ecological investigations. Materials are being collected for a detailed study of the *bonsums* (*Phabe*) of Assam of which our knowledge at present is limited.

BIHAR AND ORISSA.

Fomes tricolor has been discovered doing a great deal of damage in our *sal* forests. The attack is generally in rings, but individual

attacks have also been noticed. Generally trees of middle ages in quality III moderately dry localities are attacked, but some trees in moderately well drained and moist valleys have also been found to be attacked. The parasitic nature of the fungus does not appear to have been worked out in respect of *sal* in India. A specimen has been sent to Kew by the Forest Research Institute for verification and any information with regard to its mode of life that may be available there.

BURMA.

Botanical research was undertaken by the Utilisation Circle, Rangoon, until 10th October 1932 when the herbarium was sent from Rangoon to Maymyo and was placed in charge of the Silviculturist in addition to his duties.

The curator of the herbarium reports that the herbarium was maintained in excellent condition. Over 2,377 sheets were mounted during the year, thereby bringing the total to 36,382 sheets at the close of the year. A considerable number of partially named specimens were sent to Kew, the Forest Research Institute, and the Royal Botanic Gardens, Calcutta. More than 3,000 specimens were collected in Rangoon by the Forest Botanist and his staff and there are about 2,000 unmounted specimens which will be dealt with during the rainy season.

The contributions were received from the following :—

(i) Mr. F. Allsop, Forest Economist, Rangoon.

(ii) Mr. L. Tin Wah, Divisional Forest Officer, Thaton.

(iii) Mr. C. E. Parkinson, Forest Botanist, Dehra Dun.

CENTRAL PROVINCES.

A botanical survey of various parts of the Betul district has led to the identification of some 400 species. Most of the work was done in the rains but it was started somewhat late in the season. It is hoped to be able to make an earlier start next year and that further species will be identified.

Fungal attacks on lac by a species of *Pythium* were observed in several ranges in Damoh division. *Bandha* (*Loranthus longiflorus*) was removed from 2,541 *char* (*Buchanania latifolia*) and 407 *mahua* (*Bassia latifolia*) trees in forest villages in Yeotmal division.

West Berar.—In the Bhongaon reserve of the Buldana sub-division the fungus, *Fomes pappianus*, continued to cause damage to *babul* (*Acacia arabica*).

PUNJAB.

Succession of vegetation in burnt areas.—Changes in vegetation after a severe burn are being studied and recorded twice annually (spring and autumn) in two experimental plots started last year in Lower Bashahr division. All unknown plants met with were identified by the Forest Research Institute. *Indigofera* and brambles are now increasing and killing out many herbs. Poplar is also invading the plots and natural regeneration of *kail* (*Pinus excelsa*) is just appearing.

Vegetation in spruce and silver fir forests.—Unknown plants met with in the course of the study of the associate vegetation in spruce and silver fir forests in Kulu division were identified by the Forest Research Institute.

CHAPTER IV.—FOREST ENTOMOLOGY.

ASSAM.

The Forest Research Institute identified specimens of the *toon* (*Cedrela toona*) shoot borer *Hypsipyla robusta* and a defoliator of *gomari* (*Gmelina arborea*) *Calopepla leayana* from the Garo Hills, also a pyralid borer of *sam* (*Artocarpus chaplasha*) shoots from Sylhet.

Specimens of insects and damaged packing cases and matches were sent to the Forest Research Institute from the Assam Match Factory at Dhubri for identification and advice as to control. The insects were identified as *Heterobostrychus æqualis* and *Minthea rugicollis*.

Further damage in *hollock* plantations of Sadiya by *Dihammus cervinus* and *Phassus* species was reported and shown to the Inspector General of Forests during his tour. He was of opinion that the damage was largely due to the excessive density of the crops.

BURMA.

(1) *Xyleutes ceramica Wlk., the Beehole Borer. Life History.*—The young larvæ with which the Thogale cage was successfully stocked have entirely disappeared during the year. As this experiment was carried out under absolutely natural conditions in the optimum habitat of the insect, it is an indication of the extremely high mortality that must always occur. The possible stocking of the trees in this cage was the full complement of eggs of a single female. The usual visit was paid to the Thogale plantations during the moth season but this year emergence was a little earlier than expected and although ten days were spent in the plantations no female moth could be obtained.

The recently emerged larvæ, about 60, introduced into the outdoor cage in Maymyo have also all disappeared; a very high proportion of these succumbed during the first few days. This cage was used for determining the increase in size with age, but the stock lasted only until August, when the last surviving larva, then quite large, was removed. As regards the new brood in the Zibingyi outdoor cage, resulting from the oviposition of a single female, one larva still survives and was working on 10th June 1933. It was not possible to start fresh broods *ab initio*.

Life History Observation Plots.—In Plot 1, Thogale, South Toungoo, the 1931 attack has been reduced to 26 larvæ, which then carried on into their second year. Of these eight completed their development and emerged as moths during the hot weather of 1932. Six were males and two females. Of this 1931 attack, which commenced with 405 beeholes, only 6 per cent. passed through the first year, whereas nearly

one third of these survivors passed through their second year, final emergence being about 2 per cent. of the original attack. The original attack so called is that which is recordable when larvæ are about a month old and is itself probably only a minute fraction of the original number of eggs hatching. Of the 1932 attack the original record in June 1932 shows 385 beeholes, but not much reliance can be placed on this figure of original attack, as at this comparatively early stage the larvæ frequently leave their incipient galleries and commence new ones. Of this attack only about 50 larvæ were found working in March 1933.

Again, the attack of the year produced a few moths, on this occasion four only, but it appears quite definite that these four moths were from the 1932 attack and are instances of a one year life cycle. The moths which emerged of the 1931 attack were very clear cases of a two years' life cycle, as many of them have an unbroken record since January 1932.

Analyses of past attacks.—During the course of the year Bulletin No. 29, *Measurements of the Damage to Teak Timber by the Beehole Borer Moth*, by Mr. C. W. Scott, has appeared, giving the results of the survey of beehole conditions. His conclusions corroborate the view expressed in last year as to the connection between beehole incidence and rainfall.

Natural enemies.—A collection was made of natural nests of various species of woodpeckers and those of *Dinopicus* were considerably larger than the artificial nesting boxes previously erected in South Toungoo. The natural nest has been copied and half a dozen of this type have replaced the old ones. Though the experimental bat roost has shown no signs of occupation, yet ever since the introduction of the bats they have been seen on each occasion that the observation plot has been visited, whereas they had never previously been noticed. It is quite possible, therefore, that a number of those introduced have taken up their abode in some old tree or other suitable spot.

(2) *Defoliators.*—The work at the Pyinmana insectary was continued during the year. The generation series of *Hapalia machæralis* Wlk. has continued without a break. The dominance of the female has been the subject of several experiments, though there are no indications as to the cause of this phenomenon. Under the climatic conditions of Pyinmana this insect undergoes no resting period but is active throughout the year. No alternate host plant has been discovered, and it is believed that *H. machæralis* maintains itself during the leafless period of teak on coppice shoots, etc. Considerable progress has been made in the technique of breeding the parasites of this insect. During the year three new parasites have been discovered, a chalcid multiple ectoparasite of the 5th instar pupating larva, and 2 chalcidoid egg parasites.

All three have shown themselves easily susceptible to breeding under laboratory conditions.

Hyblæa puera Cram.—This insect is capable of running through 13 generations during the year. The laboratory experiments were paralleled during the cold weather by outdoor breeding and no difficulty was experienced in running the generations through their normal course in the open air. This seems to indicate that, like *H. machæralis*, *H. puera* experiences no resting period. *Hyblæa puera* has 12 species of host plants in addition to teak. This probably accounts for its much earlier appearance during the rains than *H. machæralis* as a serious defoliator.

(3) *Other pests of teak.*—Shot-holing in converted teak was investigated, several consignments of converted timber having been reported as arriving in England in a " wormy " condition. The cause of the shot-holing was *Dinoderus ocellaris* (*pilifrons*), emerging in numbers from the bamboo dunnage during the voyage. No gallery was found to penetrate the timber more than ½", the majority merely grazing the surface. Stocks of unused dunnage were examined in Rangoon godowns and found to be heavily infested with the beetle. It was recommended that ships carrying timber should be cleared of their old dunnage and supplied with clean water borne bamboo.

(4) *Calopepla leayana* Latr.—Attack by this insect in the *Gmelina arborea* plantations at Namtu was not very serious during the 1932 rains. The early development of the insect was considerably retarded by heavy rains during May, and some two lakhs of ovipositing beetles were hand-picked. Parasitism of the first generation of the year was high, and no second generation materialised and no serious defoliation took place in the River Series. In the Railway Series the moribund stock was unable to support the large numbers of insects that had carried over from the previous year, and though no second generation materialised, the numbers of the first were sufficient to defoliate the area completely.

It was found possible by cold storage to retard the development of the parasite *Brachymeria* sp. within the host for a period probably sufficiently long for stocks to be held in safety until required, and a new chalcidoid egg parasite was discovered in Toungoo.

Communication was opened with the authorities in the Federated Malay States regarding a proctotrypid egg-parasite of an allied chrysomelid, *Aspidomorpha miliaris*, and a consignment of parasitised egg masses of this insect was received from them.

(5) *Xyleutes persona Le G.*—*Cassia renigera* trees were sleeved and 19 moths were obtained of which two females succeeded in assembling males and mating. Fertile eggs were obtained which produced larvæ after 12 days. These newly hatched larvæ were released on caged trees

and a small proportion of them has continued to work to date. The moths taken in Pyinmana emerged from the end of June to end of October.

(6) *General Insectary Work.*—207 cages were in use at the close of the year, mainly for wood-borers. Including the figures from the insectary at Pyinmana 17,067 insects emerged during the year, and 6,291 were set and mounted.

CENTRAL PROVINCES.

(1) *Hoplocerambyx spinicornis* : the epidemic attack of the *sal* borer which occurred some years ago was of such severity in several divisions that constant vigilance is still necessary to guard against a recrudescence. The following reports have been received :—

Jubbulpore.—No fresh attacks in Murwara and Sehora ranges. Balaghat.—The attack was mild and negligible ; 415 trees in Baihar range were cut and stacked for burning ; 2,519 beetles were destroyed during June and July 1932. Mandla.—The attack was sporadic, but as a precaution, trap tree operations combined with beetle catching were carried out on a small scale, as follows :—

Range.	No. of trap trees.	No. of beetles caught.	Expenditure.
			Rs.
Banjar	778	2,969	54
Motinala	229	1,335	16
Dindori	300	354	11
Karanjia	..	170	..
TOTAL .	1,307	4,828	81

Raipur.—The attack was somewhat serious in the south of Sitanadi and Risgaon ranges. 3,915 borer attacked trees were dealt with :—Sitanadi range 637, Risgaon 2,815, Nagri 89, and Birguri 374. During the rains of 1933 it is proposed to undertake trap tree operations. Bilaspur.—A mild attack in Kota range. All attacked trees were felled and either converted or burnt.

(2) *Coelosterna scabrator.*—This borer is still a common pest in *babul* (*Acacia arabica*) areas in West Berar division.

(3) *Tonica niviferana.*—The *semal* budworm is again reported in the Chorbaoli plantations of Nagpur-Wardha division ; spraying with asafœtida and soap solution is said to provide some relief.

(4) *Animals.*—Rats, bison, blue bull, chital and hares are blamed for various forms of damage in the agri-silvicultural plots in Yeotmal. *Suria* (*Xylia dolabriformis*), *nim* (*Azadirachta indica*) and *sewan* (*Gmelina arborea*) are apparently most susceptible, while *semal* (*Bombax malabaricum*) plantations are stated to have been ruined by hares. In Balaghat, in order to study the effect on regeneration of browsing by deer, fenced and unfenced plots have been laid out in Supkhar range.

(5) *Lac.*—The following dates of swarming are reported :—

Division.	Kusum.		Ghont.		Palas.		Khair.	
	Jethvi.	Nagoli.	Baisakhi.	Katki.	Baisakhi.	Katki.	Summer.	Winter.
Damoh .	..	..	17-7-32	5-11-32	17-7-32	5-11-32	..	..
Bilaspur .	30-6-32	5-11-32 to 11-11-32 and 1st week of December.	..	..	15-6-32 and 18-7-32 to 23-7-32	30-11-32	..	..
Saugor .	..	..	20-7-32 to 30-7-32	9-11-32 to 23-11-32	20-7-32 to 30-7-32	9-11-32 to 23-11-32	..	..
Raipur .	8-7-32 to 16-7-32	13-1-33 to 21-1-33	..	..	25-6-32 to 8-7-32	10-11-32, 1-11-32 and 1-12-32	15-7-32	16-1-33
Bhandara .	..	..	..	..	17-7-32	19-11-32	..	..
Mandla .	..	..	..	..	9-7-32	11-11-32	..	..

PUNJAB.

Gall insect damage in Muzaffargarh poplar forests is severe; the capsules are badly attacked and the fruit generally falls prematurely. Defoliation is severe in March.

The *shisham* (*Dalbergia sissoo*) defoliator (*Plecoptera reflexa*, Guer.) did immense damage in Khanewal plantation in June 1932. The remedy seems to lie in mixed crops, and in the destruction of the defoliator by starlings, crows and other natural parasites. A bark boring beetle, the larvæ of which make galleries in the cambium is killing patches of healthy *shisham* in Khanewal plantation.

CHAPTER V.

UTILISATION AND ECONOMIC RESEARCH.

ASSAM.

(1) *General Work of Administration.*

The lack of a Utilisation Officer continued to be seriously felt, and with the post of the second Conservator held in abeyance, it has been found impossible for one officer to tour and supervise the large and scattered areas of forest of which the province is composed. As a result, in no small measure, of the tour of the Inspector General of Forests during November and December and his subsequent recommendations to Government, a senior I. F. S. officer was attached to the Direction division from 1st March 1933.

(2) *Paper Pulp.*

Extraction of *muli* (*Melocanna bambusoides*) bamboo in Cachar by the India Paper Pulp Company was continued.

In Sylhet, the Lawacherra-Naraincherra Road bamboo *mahal* was sold for Rs. 200, for supply of bamboos for paper pulp to the same company.

(3) *Timber Testing.*

Further experiments, as referred to last year, were made to ascertain whether intermediate thinnings of *hollock* (*Terminalia macrocarpus*) would be utilised for veneer purposes by the Assam Saw Mills at Murkong Shellek. Specimen logs were supplied from Sadiya, Lakhimpur and Sibsagar divisions. It was found however that due to borer holes, hidden knots from dead side branches, and incipient decay, the utilisation of timber of such small sizes for veneer work was impracticable.

(4) *Wood Preservation.*

Two sample sheds were erected at Jaipur *hat*, one constructed of treated timber, principally *morhal* (*Vatica lanceaefolia*), and the other of untreated timber. Suitable notices in vernacular explaining the object of the experiment were put up in the sheds. The poles were impregnated under pressure at the Naharkatiya plant. Some enquiry for treated fencing posts from tea gardens were received, and an endeavour was made to start a commercial undertaking with the Assam Bengal Railway authorities. No final arrangement has so far been concluded.

(5) *Timber Seasoning.*

Nil.

(6) *Minor Forest Produce.*

Air dried roots of *Derris elliptica* were supplied to the Forest Research Institute, Dehra Dun, for chemical research as an insecticide.

BENGAL.

(1) *Wood Technology.*

(*a*) Twelve pieces of *sundri* (*Heritiera* spp.) were supplied from the Sunderbans division to the Eastern Bengal Railway, to see if they would do for hammer and *powrah* handles and wooden beaters, but they were not found suitable.

(*b*) 12 pieces of *hantal* stems (*Phœnix paludosa*) were supplied to the Chief Mechanical Engineer, East Indian Railway, for trial as hammer handles; they also were found unsuitable.

(*c*) Teak wood (*Tectona grandis*) from Kaptai (Chittagong Hill Tracts division) was used in our departmental dockyard at Khulna for repairing boats. The timber is reported by the Divisional Forest Officer to be suitable for use in superstructural work, but not as good as the best Burma teak for construction of hulls of new boats.

(*d*) The sample of *sundri* (*Heritiera spp.*) supplied to the Engineer Superintendent, Narayanganj Government Dockyard, for ribs of boats, were found suitable and 10 logs were supplied to him for conversion in his own workshops.

(*e*) Samples of *sal* (*Shorea robusta*), *kakur* (*Acacia lenticularis*) and *khair* (*Acacia catechuoides*) logs were supplied from the Siliguri Depot to the Superintendent, Presidency Jail, for oil mill pestles. No results are yet to hand.

(*f*) The following samples were despatched to Messrs. F. N. Gooptu & Co., Calcutta, for making pencils and pen-holders :—

Cryptomeria japonica for pencils.

Gamar (*Gmelina arborea*), *dar* (*Bœhmeria rugulosa*) and *karam* (*Adina cordifolia*) for pen-holders.

No report yet received.

(*g*) A sample plank of birch (*Betula alnoides*), was supplied to Messrs. Kamarhati Tea and Lead Mills, for testing its suitability for corner pieces of tea chests. The following report was received :—" We regret to say that this quality of timber is not suitable for the manufacture of tea

chest battens on account of its very high cost, hardness and heaviness."

(*h*) Report on the sample piece of *Cryptomeria japonica* sent from Darjeeling division in May 1930 to Messrs. Bauls and Co., Calcutta, for pencil manufacture was received during the year. It was found unsuitable for the purpose. They report that it is quite suitable in weight, but the timber in mass is very soft and contains a very hard and strong lining of fibres every quarter of an inch apart, which stand against plain moulding.

(2) *Timber Seasoning.*

(*a*) The 18 teak logs (*Tectona grandis*) kept under water for seasoning were washed away last rains (1932).

(*b*) Information to date for the girdled teak (*Tectona grandis*), in Chittagong Hill Tracts division is as follows :—

Average height 103′ and 100′ (two areas)

Average Breast Height Growth 6′-0″ and 5′-7″ (two areas)

Average age 1885-86-87 and 1890-91 (two areas)

Girdled 1931 and 1932 (two areas)

It is proposed to send samples of each to the Forest Research Institute in 1934 and 1935 respectively for testing and a comparative report based on Burma teak.

The Divisional Forest Officer reports that the Breast Height Growth has been reduced by about 3″ in each case since the trees were girdled. 10 more teak (*Tectona grandis*) trees were duly girdled during the year under report.

(3) *Timber Testing.*

(*a*) 5 *Alnus nepalensis* logs were despatched from Darjeeling division for testing under Project 1 in April 1932. No report is yet to hand. We want to compare it with birch (*Betula alnoides*).

(*b*) The following report was received from the Forest Research Institute on the 4 logs of birch (*Betula alnoides*) despatched from the Kalimpong division, for testing in peeling, veneering, machine working, etc., under Project VIII.

"Upon arrival at this Institute the consignment was given test number 106, by which number it will hereinafter be known. A gross inspection of the logs indicated that fungus was present and this was later confirmed by microscopic examination. A quantity of the timber was made up into plywood and a further lot was submitted to working quality tests, *i.e.*, sawing, machining, turning, and finishing.

Test procedure :—(Plywood).

The logs were converted into 1/16" veneers by the rotary process, they peeled easily and economically without having to be subjected to any preliminary boiling or steaming treatment and the resultant veneers were clean and tight. These veneers were next made into 3-plywood using casein cement as the adhesive, the finished panels being made up into 19"×19"×24" tea chests. Standard commercial metal fittings were used in the assembly.

Completed boxes were next subjected to a number of tests with the following results :—

1. Diagonal Edge Compression Tests.
2. Corner Drop Test.
3. Drum Box Test.
4. Static Bending.
5. Shearing or Glue Adhesion Tests.

Test No. 106 presented little or no conversion difficulties by either frame or circular saws, it cut freely with good results under ordinary workshop conditions. Birch machines, turns and polishes well but as the grain is liable to raise, it is advisable to damp the surface before the final sand-papering prior to polishing.

Except for the fact that there was a certain amount of fungus present, the *Betula alnoides* under review appears to be a very suitable timber for manufacturing into plywood for tea chest and other forms of containers. As plywood it should also be suitable for all the several purposes, ornamental plywood excepted, to which imported plywood is put. From the results of our tests we consider Test 106 boxes to be equivalent to imported standard boxes. Though a little weaker than the standard boxes when empty, as indicated in the edge compression test, they surpass the standard boxes in the drum box test, which test we consider of prime importance.

In solid form, birch appears to be suitable for making wooden tools, small tool handles, boot trees, lasts, bobbins of kinds, fitments, furniture, etc. Exhibit tool handles, tools, and a tea chest made from Test 106 materials, are being forwarded to you for propaganda work if necessary."

(4) *Wood Preservation.*

Report on the 200 metre gauge sleepers of *Acrocarpus fraxinifolius* supplied last year from Kalimpong division for testing in line under Project IV has not yet been received from the Forest Research Institute.

(5) *Wood Working.*

The 100 c.ft. of *toon* (*Cedrela toona*) sent to the Timber Adviser to the High Commissioner for India, London, was treated by a firm's special process which colours the wood a silvery grey, and certainly produces a very pleasing effect; the following report has been received from Messrs. Drytone, Ltd., on the subject:—"This timber arrived very wet indeed and cannot be used for any large work until it has thoroughly dried. A small quantity of it however has been used for mouldings and the impression is that the wood is a treacherous one and we could not make use of it for our work, which is of a high grade, and requires thoroughly reliable and seasoned timber. We regret that we cannot give you a better report."

(6) *Matchwood.*

The following species were supplied to the Western India Match Company for testing their suitability for match splints and box veneers and the reports are summarised as noted :—

(*a*) *Civit* (*Buchanania lancifolia*).—The wood is too hard for the peeling machine. The wood grows dark during manufacture and sticks become bent after drying. For these reasons the wood cannot be used for stick-manufacture. The wood blocks can hardly be peeled in box-peeling machines on account of the hardness of the wood. The boxes turned out are strong and *civit* wood might be suitable for box-manufacture if it could be peeled.

(*b*) *Tanki* (*Bauhinia* spp.).—The fresh surface after cutting was of light colour but changed quickly into dark brown. The wood is easy to peel but the veneers are difficult to run through the next machine owing to the peeled strips rolling up tightly. Outside as well as inside boxes turn out well. Disregarding the bad colour, *tanki* wood is rather good for manufacture of match boxes. On account of the dark colour *tanki* wood cannot be taken into consideration for manufacture of matches.

(*c*) *Lampatti* (*Duabanga sonneratioides*).—Cross section homogeneously brown. Very hard wood rendering it necessary to grind the knives in a special way. Veneers yellow-brown; cross grained. Dying —good. Veneers inclined to keep the round shape of the log, causing difficulties in the feeding part of the machine. Veneers strong. The paste sticks well on the veneers. Boxes, specially inner boxes, break easily. The splint obtained is very dark and not suitable for match making, even though the impregnating seems to improve the colour somewhat. The sap seems to contain a liquid discolouring the blue box paper.

(*d*) *Panisaj* (*Terminalia myriocarpa*).—The outer part of the cross sections brownish and centre grey-green colour. Very hard wood, necessary to grind the knives in special way. Veneers from outer part of the log dark coloured. The centre cannot be used for splints, rather cross-grained. The dye will not stick to the veneers properly. The veneer is strong, but when fashioned over the mandril to a box, the fibres of the outer surface of the veneer do not bend at the edge of the box, but break about $\frac{1}{8}$th of an inch's distance from the edge. The edge becomes thus fringed and the blue box paper will not fasten properly at the edges. Veneers good for inner boxes. The ends of the outer boxes are inclined to split easily. The splint obtained is very dark and not suitable for match making, even though impregnating seems to improve the colour somewhat. Apart from the remarks given above, the boxes are quite good.

(*e*) *Dude lampati* (*Litsæa khasyana* var. *hookeri*).—Rather hard wood; cross section yellowish green; centre dark grey. Veneers dark yellow. Very cross-grained. Dying—good. Large quantities of cross-grained veneers had to be separated. The rest run well in the machine, but a number of boxes get a very round shape. Difficult to run the the machine. Boxes very irregular. The paste will not stick to the veneers properly. Boxes strong.

The splint obtained is yellow. In consequence of the multitude of cross-grained splints, this kind of wood cannot be considered suitable for match making.

(*f*) Samples of *harikel* (*Sterculia alata*), *civit* (*Buchanania lancifolia*), *chundol* (*Swintonia helferi*), *latikaram* (*Hymenodictyon excelsum*), and *phirphiri* (*Sterculia colorata*) were supplied to the Karimbhoy Match Manufacturing Co., Calcutta. Their report on *latikaram* and *phirphiri* was favourable. No report has yet been received on the other species.

(*g*) Samples of *udal* (*Sterculia villosa*), *mandani* (*Acrocarpus fraxinifolius*), *kunil* (*Trema orientalis*) and pipli (*Bucklandia populnea*) were supplied to the Western India Match Company, at the close of the year.

(7) *Minor Products.*

(*a*) The following reports were received from the Forest Research Institute on the *tung* oil seeds sent from the Sukna range of Kurseong division, for analysis :—

Aleurities fordii :—

	Per cent.
Shell	38·5
Kernel	61·5
Moisture in kernels	19·6
Oil contents in kernels	33·2
Oil contents in kernels on moisture free basis	41·3

	Per cent.
Aleurities montana :—	
Shell	40·0
Kernel	60·0
Moisture in kernel	16·1
Oil contents in kernel	44·0
Oil contents on moisture free basis	52·5

(*b*) 1 tin of *gurjan* oil was despatched from Chittagong division to the Forest Research Institute for testing its suitability for paint and varnish making. The report on the subject is as below :—

" From such rule of thumb experiments as were carried out, reasonably good quick drying varnishes were obtained by mixing equal parts of resin, turps and *gurjan* oil, and there seem good prospects of the oil being suitable as an agent in paint and varnish making."

A sample of 10 lbs. has since been sent to Messrs. Napier Paint Works, Calcutta, for testing it out under commercial conditions.

(8) *Paper Pulp.*

16 lbs. of *Dendrocalamus hamiltonii* bamboo was despatched to the Forest Research Institute for testing its suitability for pulp. The report says that it can be easily converted into bleaching pulp.

4 kinds of bamboo, *viz.*, *mitenga* (*Bambusa tulda*), *dolu* (*Teinostachyum dullooa*), *orah* (*Dendrocalamus longispathus*), and *kaliseri* (*Oxytenanthera auriculata*) were despatched from Chittagong division to the Forest Research Institute for testing their suitability for pulp. A good report has been received, *viz.*, that they are capable of being converted into pulp and can be used together. The Forest Research Institute is now engaged in carrying out semi-commercial tests on all the above species of bamboos.

(9) *Tans.*

The following report on *goran* bark was received from the Imperial Institute, London, through the Timber Adviser to the High Commissioner for India, London. " *Goran* bark is the bark of *Ceriops roxburghiana*, one of the many trees known as mangroves. According to Fraymouth and Pilgrim (Bull. No. 1, 1918), of the Indian Munitions Board, *Ceriops candoleana* is known in the Sundarbans as *goran*. Samples of these barks were examined at the Imperial Institute in 1899. Three samples of *C. candoleana* bark from Bengal contained 16, 20 and 25 per cent. of tannin respectively, while samples of *C. roxburghiana* bark from Burma contained 27 per cent. of tannin. These figures and those that follow are all expressed on moisture free bark.

A sample of *C. roxburghiana* bark was collected by Pilgrim ("Tanstuffs of the Sundarbans Forest Division," by J. A. Pilgrim, 1920) in the course of his survey of the tannin materials of the Sundarbans in 1920; and analysed by him to contain 37 per cent. of tannin. A sample collected subsequently by Dhavall of the Bengal Tanning Institute (Department of Industries, Bengal, Bull. No. 20, 1924) contained 36 per cent. of tannin. These samples of bark were well prepared, that is to say they were thoroughly dried at the time of collection. The bazar *goran* bark of Calcutta, however, is not stripped till the logs have reached the city and the fermentation which has taken place in the interval between felling and drying causes loss of tannin. Such bazar bark contains usually only 20 to 30 per cent. of tannin, while the colour is also adversely affected.

Goran bark has a bad reputation in India as producing an ugly red coloured leather which is liable to crack, and has only been used in the past for cheap tannages. Investigations at the Bengal Tannery Institute have shown that by blending *goran* bark with myrobalans and *babul* bark in suitable proportions, the redness due to *goran* can be eliminated to a considerable extent.

Mangrove bark derived from species of *Rhizophora*, *Bruguiera*, and *Ceriops* has long been known to tanners throughout the world, and though large supplies of the material are available, it has never become popular on account of the objectional red colour which it imparts to the leather and the poor quality of the tannage. East Africa produces a mangrove bark containing up to 45 per cent. of tannin, which is exported mostly to Germany and America. British North Borneo has an established export trade in the extract made from bark containing 20 to 30 per cent. of tannin, which is considered too low in tannin content to export as bark. The Philippines are also producers of extract. The United States of America in 1930 imported 4,000 tons from this source. The use of mangrove bark in Europe and America may be taken as very restricted, on account of the objections to it. It would appear to be used for blending in compound extracts. In England its use appears to be increasing but the amount used is still very small.

With regard to the establishment of an export trade from India, it would appear that the most promising line of development would be export in the form of extract. It would not be advisable, however, to encourage this without first consulting the tanning trade on the prospects to-day of extending the use of this material in English tanneries. For this purpose I suggest, with your approval, bringing the matter before the next meeting of the advisory committee on tanning materials, at which you would perhaps be good enough to present the case for the Indian product, and if possible state the extent of the supplies which are likely to be available for export trade."

In continuation of the above report the Secretary to the Advisory Committee on Tanning Materials forwarded the following :—" I have to inform you that the prospects of marketting *goran* bark, or an extract of it, in the United Kingdom, were considered at the last meeting of the Committee. Mangrove is a very unpopular material with English tanners, on account of the red colour and the poor quality of the leather it produces. It is used only to a slight extent in this country and its use is unlikely to be materially extended. In these circumstances the Committee cannot recommend the marketting of *goran* bark or extract in England, though the material might possibly find a market on the continent or in the United States of America. It should, however, be borne in mind that ample supplies of bark from East Africa and of extract from Borneo and the Philippines are already available through commercial channels."

(10) *General.*

The following general points of interest are reported :—

Increase in the sales of round *sal* (*Shorea robusta*) to the Railways and to merchants in Eastern Bengal.

Increase in the sales of match-wood timber.

Reduction in Eastern Bengal Railway rates of freight.

Reduction in Assam Bengal Railway rates of freight.

Reduction in river steamer rates of freight.

Reduction in shipping company rates of freight.

Our inability to extract *gurjan* (*Dipterocarpus* spp.), *tali* (*Dichopsis polyantha*), *pitraj* (*Amoora rohituka*), *chaplash* (*Artocarpus chaplasha*), *chickrassy* (*Chickrassia tabularis*), *toon* (*Cedrela toona*), match-wood timber, etc., from Chittagong Hill Tracts division, and consequently our failure to quote for, or supply, even the smallest order.

Our inability to offer *gurjan* (*Dipterocarpus* spp.) for the London market, because of lack of facilities for extraction and sawing. The time will soon come when we shall have to do something about a sawmill at Chittagong for sawing *gurjan* (*Dipterocarpus* spp.), etc.—as soon as we have solved the extraction question. Even had we been able to extract, we could not have undertaken the above orders for squares and boards without a sawmill. During the year under report the Great Indian Peninsula Railway placed an order with the Assam Railway and Trading Company, Ltd., for 210 tons *gurjan* (*Dipterocarpus* spp.) boards at Rs. 97-10 ton f..o.r. Matunga Works (Bombay). These boards were sawn and extracted at Margherita, near Dibrugarh, 800 miles North East of Calcutta and railed the whole way to their destination.

Properly organised, we should easily be able to compete for such an order especially considering that we could send the consignment the whole way by sea to Bombay from Chittagong.

If we had a mill at Chittagong we could compete against Burma and the Andamans for the *gurjan* (*Dipterocarpus* spp.) market in Bombay and London, as well as in East Bengal.

Jarul (*Lagerstrœmia flos-reginæ*), is certainly scarce, so we shall have to induce consumers to use *sal* (*Shorea robusta*) instead unless we can tap the Sangoo reserve for *jarul*; 95 per cent. of the *jarul* or *pyinma* that is being used in East Bengal is really foreign *gurjan* (*Dipterocarpus* spp.). Necessary legislation is indicated to put a stop to this illegal practice of selling *gurjan* (*Dipterocarpus* spp.) and calling it *jarul* or *pyinma* (*Lagerstrœmia flos-reginæ*). We sent a sample of alleged *jarul* from Khulna to the Forest Research Institute for identification during the year and it was reported to be *gurjan* (*Dipterocarpus* spp.); similarly with a sample of *pyinma* from Dacca.

The demand for seasoned *sal* (*Shorea robusta*) logs and machine-sawn timber is increasing. Railways who are the biggest purchasers, will not have anything else; we have been unable to meet their full requirements of 1st class seasoned *sal* (*Shorea robusta*) logs.

There is a possibility of a bamboo paper mill being started in Chittagong in the near future. Negotiations are proceeding, but our agreement with the Indian Paper Pulp Company, which does not expire until 1941, may interfere. We hope there will be enough for everybody, especially as the Forest Research Institute reports favourably on the 4 species of bamboo ,*viz.*, *mitenga* (*Bambusa tulda*), *dolu* (*Teinostachyum dulleoa*), *orah* (*Dendrocalamus longispathus*) and *kalisari* (*Oxytenanthera auriculata*), which we sent from Chittagong for testing their suitability for paper pulp.

Dendrocalamus strictus was also sent to the Forest Research Institute for testing its suitability for paper pulp, and in its preliminary test found suitable. Further tests on this species are proceeding.

We quoted the Titaghur Paper Mills during the year for bamboos but our quotation was too high. It is difficult to market Chittagong forest produce in Calcutta because there is no direct ocean steamer service, and river steamer rates are still too high. The Forest Department is at present negotiating with the Assam Bengal Railway for a reduction in their rates.

Tests carried out by the Forest Department in Burma have found that *gurjan* (*Dipterocarpus* spp.), creosoted under pressure is the best of all species for use in marine work in resisting teredo attacks. This information has been passed on to all concerned *viz.*, Calcutta and

Chittagong Port Commissioners, Railways, District Boards, the Public Works Department, etc.

The Forest Research Institute's report on our birch (*Betula alnoides*) was excellent. The samples of tool handles, shoe trees and tea chests which they supplied with their report will be of great advertising assistance.

We have sent samples of birch (*Betula alnoides*) made up into bobbins and spools to the Director of Industries for inducing jute or cotton mills to try them. Report not yet received.

We tried floating and rafting *sal* (*Shorea robusta*) also match-wood logs and bamboos down the Tista from Sevoke to Mandalghat, the idea being to rail them on to destination from there or continue on to the Brahamaputra, Dacca, Mymensingh, Tistamukh Ghat, Sirajganj, and Goalundo. We did not get beyond Mondalghat, as it was too expensive compared with the very favourable freight rates we now enjoy from the Eastern Bengal Railway. Jalpaiguri contractors extracted *sal* (*Shorea robusta*) by boat from near the Tista river because of the prohibitive Bengal Duars Railway rates.

Kutch continued to be manufactured by contractors in Buxa division, and during the year under report manufacture was also started in Jalpaiguri division. The total revenue yielded in each division from *khair* (*Acacia catechu*) trees for the manufacture of *kutch* was Rs. 6,597 and Rs. 9,637-8 respectively.

Calculations were completed for the quantities of timber of the plentiful species (4′ 6″ midgirth and up) available in North Bengal.

Match factories in Bengal are undergoing an anxious time because of Japanese competition. 8 small boxes of quite good Japanese matches can be bought in the Kalimpong Bazar for one anna ; this is due to the deflation of the value of the yen.

The demand for soft wood species is progressively decreasing because of the cheapness, lightness and availability of imported plywood. The use of plywood is no longer confined to tea chests ; it is now being used by many other industries such as tobacco firms for packing their goods, also furniture makers. This increased and general use of plywood indicates the importance of growing species suitable for plywood in our plantations.

The protecting tariff on matches, packing case timber and pulp is not sufficient to encourage local manufacture. Possibly if there were a match factory opened at Chittagong, it would be better able to compete against foreign matches, as it would be able to procure its matchwood at about Rs. 12-8 per ton. The minimum price in Calcutta is Rs. 30 per ton.

The necessity of an Utilisation division in Bengal is growing. The total utilisation staff at present consists of a temporary orderly. The usual liaison was maintained with Divisional Forest Officers and with the Forest Research Institute. There was also co-operation with the Timber Advisory Officer, Railway Board, and the Timber Adviser to the High Commissioner for India.

BIHAR AND ORISSA.

(1) *Timber.*

The economic blizzard had a tell-tale effect on the sleeper trade, the prices of *sal* sleepers having gone down to Rs. 4-12 per broad gauge, Rs. 2 per metre gauge, and Rs. 1-4 per narrow gauge. The log markets for *sal* were, however, fairly satisfactory, although prices were low and varied between Rs. 0-7-0 and Rs. 1-4 per c.ft. for logs between 12 inches and 24 inches diameter. At present there is practically no market for miscellaneous timbers except *Adina cordifolia* and *Pterocarpus marsupium* which were mostly sold locally. There is no local demand for *Terminalia tomentosa*; a certain quantity of it was, however, exported outside the province, but the prices were very low and varied between As. 4 and As. 5 a c.ft. which hardly covered expenses. This year a Delhi contractor in the Palamau division created some market for Bihar and Orissa *sal* timber in the Punjab and Delhi, and it is hoped that he is the pioneer of an invasion by up-country contractors.

(2) *Firewood.*

The local market for firewood remained almost steady and there was no difficulty in selling coupes. The biggest market for firewood is the Tata Iron and Steel Company, which draws its supplies from the Singhbhum forests. With the price of firewood down to about Rs. 16 per wagon load of 500 c.ft., it is almost impossible to carry firewood more than 10 miles.

(3) *Lac.*

The lac market continues depressed and the T. N. rates for shellac fluctuated between Rs.15-8 and Rs. 24-8 during the year. There is hardly any sign of improvement in the market for the near future. Lac operations in departmental plantations are now limited to bare maintenance except in the Kundri natural lac orchard where departmental inoculation and harvesting continued as usual; the prices obtained for *stick lac* were as low as Rs. 7-4 and Rs. 10-4 a maund for *palas* and *kusum* respectively, at which rate there is very little margin of profit. In the Pelwal lac orchard, which is managed by the Department on behalf of the local Co-operative Society at Khunti, experimental infection of

khair hosts was carried out but failed. Efforts are being made to effect further inoculations next year. The lac market has gone down so much that even villagers, who grow lac as a subsidiary crop, find it difficult to do so on a large scale.

(4) *Kath.*

This year's *kath* (*Acacia catechu*) coupe, where 7,201 trees were marked for felling, could not be disposed of owing to the low sale price offered, namely Rs. 7,350. It is hoped that better prices will be realised next year.

(5) *Sabai grass* (*Pollinidium angustifolium*).

Messrs. Balmer Lawrie & Co., held a monopoly lease of *sabai* grass in Singhbhum, and paid a minimum royalty of Rs. 1,100 for 50,000 maunds, or As. 3-6 per maund; for anything above this they were to pay a royalty of As. 4 per maund. The total extraction amounted to about 80,000 maunds this year, owing to better supervision. The probable total output of this grass from Singhbhum is about a *lakh* of maunds, and with still better supervision it is hoped the company will be able to exploit the grass to the full.

(6) *Dyospyros melanoxylon leaves.*

Although the *bidi* industry is expanding in the province, the demand for *kendu* leaves seems to be falling off.

(7) *Bamboos.*

Bamboos are the most important minor produce of the province and will remain so. Most of the bamboo forests outside Orissa, with the exception of those of Palamau, are worked to the full capacity to supply local demands. Owing to the opening up of the district by the C. I.C. Railway, the lead to Palamau is very much shortened, and there are already signs of competition for bamboo coupes. Some of the bamboos are already exported for paper pulp by Messrs. Andrew Yule & Co. In Angul the quantity exported by Messrs. Heilgers & Co., is increasing annually. Puri bamboos are not yet fully exploited although a good deal is consumed locally. In Sambalpur there is yet a vast tract of untouched bamboo forests.

BOMBAY.

(1) *Lac.*

In the Dharwar range of the Dharwar-Bijapur division the experiment in the propagation of lac was continued during the year with promising results.

In the North Khandesh and Panch Mahals divisions the experiment was abandoned on account of continuous failure.

BURMA.

(1) *Wood Technology.*

No new specimen timbers were collected, nor were any additions made to the central collection at Rangoon. Hand-samples of common timbers of Burma were sent to various enquirers, including the American Consul and the Australian Council for Scientific and Industrial Research.

Routine identifications were carried out for the Timber Research division, and numerous requests for identification from firms and Divisional Forest Officers were also dealt with. Acknowledgments are due to the Forest Research Institute for help in doubtful cases.

A small Bulletin entitled "Photographs of the Chief Timbers of Burma as seen through a hand lens (×10)", (Burma Forest Bulletin No. 30) was published during the year.

(2) *Timber Seasoning.*

Owing to the demand for box-shooks of *mau-lettan-she* (*Anthocephalus cadamba*), it was found necessary to continue to use the Tiemann water-spray drying kilns up to the end of August 1932. They were then finally closed and the equipment, which was worn out and giving unsatisfactory service, was dismantled. Experience with a 75 c. ft. internal-fan kiln has indicated that this type is better suited than Tiemann's water-spray kiln to the conditions prevailing in Burma, so the old Tiemann kiln chambers were reconditioned, and fitted with reversible internal fans and Foxboro automatic recording apparatus. The work was almost complete at the end of the year.

During the first five months of the year 92 tons of timber were kiln-seasoned, as compared with 288 tons for the whole of 1931-32. As 78 per cent. of the timber seasoned was *mau-lettan-she*, which can be dried comparatively quickly, there was a further fall in the cost of seasoning. The cost per cubic foot was Rs. 1-15-10, a great improvement on last year's low record of Rs. 2-9-10. Reduction of staff and revision of rates of pay contributed to the saving.

Mondaing (*Lophopetalum wallichii*) was kiln-seasoned for the first time in a small mixed run with *kuthan* (*Hymenodictyon excelsum*) in the 75 c. ft. internal fan kiln. It gave excellent results, seasoning even better than *kuthan* under the conditions of the run. *Taungmeok* (*Alstonia scholaris*), another new species, was seasoned in a mixed run with *didu* (*Bombax insigne*) and *letpan* (*B. malabaricum*). It emerged from the kiln stained and discoloured, the schedule adopted evidently being un-

suitable. Scantlings, 2″×2″, of black heart-wood of *yindaik* (*Dalbergia cultrata*) seasoned under somewhat mild conditions, showed no degrade during drying.

Baing (*Tetrameles nudiflora*) responded well to seasoning under rigorous conditions, drying being accomplished in 5 days, the moisture content falling 9 per cent. per day, without introducing defects of any kind.

Considerable attention was given during the year to air-seasoning, *mau-lettan-she* being the timber handled on the largest scale. It was found to be non-refractory, but liable to blue-stain if held in the log or flitch. If converted green, piled at once in an open stack, and seasoned as quickly as possible in a dry climate, its worst defect is a tendency to end-cracking. In practice, the loss from this cause is negligible. Preliminary experiments with other timbers gave the following results:—

Ananma (*Fagrea fragrans*) was found to be a refractory wood with tendencies to surface-cracking, cupping and twisting. Slow drying is recommended.

Chay (*Gluta tavoyana*) seasoned easily, though some end-splitting occurred. The sap-wood is attacked by borers, which do not, however, affect the heart-wood.

Letkok (*Sterculia alata*) cracked badly and was heavily attacked by borers. This timber will require treatment with some toxic substance before seasoning.

Myaukngo (*Duabanga sonneratioides*), a non-refractory wood though it splits somewhat easily.

Taukkyan (*Terminalia tomentosa*) it was found, must be dried slowly and evenly to avoid heavy depreciation from surface-cracks, warping and splitting.

Teak (*Tectona grandis*) seasoned easily and well.

Tharapi (*Calophyllum spectabile*) suffered heavy depreciation during drying owing to splitting, warping and twisting. It is a timber that must be stacked carefully and dried slowly.

Thitkado (*Cedrela toona*) showed a slight tendency to surface cracking but, if protected from too rapid drying, seasoning presents no difficulties.

Thitsi (*Melanorrhoea usitata*) suffered during seasoning from borers which attacked the sap-wood and also, somewhat surprisingly, the heart-wood. Splitting and cracking also occurred.

Sagawa (*Michelia champaca*) seasoned very well indeed.

Sit (*Albizzia procera*) gave trouble by splitting and cracking, so evidently requires careful protection during air-seasoning. The sap-wood was attacked by small borers.

(3) *Timber Testing.*

The following species were sent to the Forest Research Institute, for testing :—

Taungthayet (*Swintonia floribunda*) } for Project VIII (Veneers), collected from the Insein division.
Kaunghmu (*Anisoptera glabra*). }
Thingadu (*Parashorea stellata*). }

Thitmin (*Podocarpus wallichianus*) for Project I collected from the Tavoy division.

Thitmin is not in the current programme, but it seems a very good substitute for spruce and has been used on more than one occasion at the Government Timber Depot for repairs to aeroplanes. It is slightly heavier than spruce, but it is probably stronger, though until this point has been verified by strength tests, the use, particularly in aeroplane work of slightly smaller dimensions cannot be risked.

(4) *Wood Preservation.*

During the year shippers of teak were alarmed by reports from Europe of timber arriving in a " wormy " condition the damage being attributed to *Dinoderus pilifrons*, a very common shot-hole borer of bamboo, though not previously recorded as attacking timber. The damage took place on board ship, the insect gaining access to the holds in the bundles of small bamboos (dunnage) used for packing the cargo. Specimens of damaged teak received in Burma showed shot-holes up to $\frac{1}{2}$" deep but the majority were under $\frac{1}{4}$" and many merely grazed the surface. Three consignments of *in-kanyin* (*Dipterocarpus* spp.) are said to have suffered similarly.

On investigation it was found that the holds of vessels which used bamboo dunnage contained large numbers of live *Dinoderus*. In addition to the damage to the cargo they had bored to some extent into the more or less permanent timber cribbing of the hold, fittings usually made of pine and other coniferous wood, but there was no evidence of breeding in anything but bamboo. There was every indication that damage to teak and other timber was purely accidental, Conditions in the hold prevented the adult beetles emerging from the bamboos during the voyage for flighting off, as they would do in the forest, and they devoted themselves to mischievous boring in the surrounding cargo. It is most remarkable that damage of this type has never been recorded before, but it is thought that an aggravating factor is increased incidence of *Dinoderus* owing to the comparatively recent change from water-borne to rail-borne bamboo for dunnage. Every jungle villager knows that bamboo which has been soaked in water is less attractive to shot-hole beetles than unsoaked bamboo, and there is no doubt that rail-borne

dunnage carries a bigger population of *Dinoderus* than did the material formerly brought in by water.

It was suggested by the shippers that the difficulty could be surmounted by the use of stick dunnage, but it was pointed out that the mixed woody species of which this consisted would be more liable than bamboo to harbour timber borers. An alternative much more likely to give satisfactory results is the use of water-borne or soaked bamboo, and experiments to determine, if possible, the conditions of soaking required to give immunity from *Dinoderus* have been put in hand. Bamboos have been soaked in stagnant-fresh, stagnant, and running brackish water for varying periods up to 3 months, then placed in contact with unsoaked controls and bamboos containing active shot-hole beetles. The experiment is still in progress. It has, however, been discovered that after two months' immersion in the Rangoon River, bamboos are so heavily attacked by teredo as to be useless, and it is evident that soaking in brackish water can only be used in practice under the most careful supervision. Ships can be cleared of *Dinoderus* if no bamboo dunnage is used for about three months and, if, as is expected, practical immunity can be conferred by soaking, it is thought it will be possible to continue to use bamboo dunnage with timber cargoes without cause for anxiety.

(5) *Minor Forest Produce.*

There were numerous enquiries regarding minor forest produce. Cutch samples submitted by Messrs. Ellermans Arracan Rice and Trading Co., were analysed at the Rangoon University by the Perkin and Yoskitaki's method (as modified by the Imperial Institute, London). Five samples of Burma cutch showed variation in catechin content from 3·74 to 19·05 per cent. Indian "Krystal" cutch gave 10·84 per cent catechin. The results were communicated to the firm which provided the samples and to the Forest Research Institute.

There was received from the Imperial Institute, London, a detailed report on experiments carried out with a view to determining the utility of cutch containing catechin for treating twines which are exposed to sea-water. The results showed that twine treated with mangrove cutch containing no catechin suffered less deterioration than that tanned with cutch containing catechin. The report was circulated to all interested parties including the Forest Research Institute and Messrs. Finlay, Fleming & Co., Ltd., Rangoon.

Samples of *tuba* root (*Derris elliptica*) collected near Mandalay were examined during the year under report by the Department of Insecticides and Fungicides at Rothamsted. The sample was divided into (*a*) fine roots $\frac{3}{8}$" and under, (*b*) medium-sized roots of approximate diameter 1", (*c*) coarse roots of approximately 3" diameter. They were

ground and examined separately for their insecticidal value and content of rotenone. None of the samples was found to have any material insecticidal value nor to contain any weighable quantity of rotenone, hence there appears to be no likelihood of Burma species of *Derris* replacing the Sumatran product in the export market.

After further enquiries it was found that the probable supplies of *Edgeworthia gardneri*, referred to in last year's report, were too small to merit further investigation.

The enquirer from New Zealand referred to in last year's report, reported that *kyathaung* bamboo (*Bambusa polymorpha*) proved excellent for the walls of cheese crates but he was unable to find an immediate market.

There were numerous enquiries from Germany, Czechoslovakia, Holland, etc., for small bamboos for ski-sticks and umbrella handles. Hitherto *tonkin* bamboos from China were used for this purpose, but it is presumed that the present unrest in China has caused a failure in supplies. The main demand seems to be for a strong bamboo from $\frac{1}{4}$" to 1" diameter, in lengths varying up to 7' or 8'. The most likely of the common Burmese bamboos to fill this demand is *kayinwa* (*Melocanna bambusoides*) but the culms are thin-walled and it is feared it is hardly strong enough to replace *tonkin*.

A sample consignment of 4,000 *kayin* bamboos cut into 4' lengths was despatched during the year to Messrs. F. Westbury and Son, Ltd., London. It is understood that the bamboos would be given a trial as umbrella handles but no report has yet been received from the firm as to their suitability.

About 1 cwt. of *in* (*Dipterocarpus tuberculatus*) oil was collected from the North Toungoo division and despatched to Mr. P. C. Mitter of the Calcutta University College of Science and Technology, who is engaged on a determination of its physical and analytical data. Interim results show that the oil contains a considerable proportion of bicyclic sesquiterpenes.

One bag of " air-kusum " and one bag of " phunki-kusum " (" wet " and " dry ") lac from *gyo* (*Schleichera trijuga*) were sent to the Indian Lac Research Institute, Namkum. A detailed report on the present conditions of the lac industry in Burma based on the observations of her tour in the lac growing areas, was published by the Director of the Lac Research Institute, Namkum. The sliding scale of export duty on lac, introduced two years ago, continues to work satisfactorily. To furnish further funds for research, an increase in the cess on lac exported from India has been suggested. The proposed increase will have no appreciable effect on exports from Burma, as almost all the lac from this country is sent to India.

Aleurites fordii (*tung*) planted in the Taunggyi Fuel Reserve, Southern Shan States, in. 1929, flowered for the first time in March-April 1932, and produced normal fruit which ripened at the end of September. The fruit, tested at the Forest Research Institute, Dehra Dun, gave the following results :—

	Per cent.
Shell	38·4
Kernel	61·6
Moisture in kernels	4·2
Oil content in kernels	46·5
Oil content in kernels (on moisture free basis)	48·5

A. fordii and a little *A. montana* have been planted at Hsumhsai, Northern Shan States. A few trees put down in 1929 and 1930 flowered and produced fruits in 1932. This fruit has been sent to the Imperial Institute for analysis, and it has been arranged to supply, in due course, other samples of Burma-grown fruits for detailed examination by the Director of the Research Station of the British Paint, Varnish and Colour Manufacturers Association.

At the instance of the editor of the *Empire Forestry Journal*, specimens of mineral deposits from *thinwin* (*Millettia pendula*), together with specimens of wood containing a little of the mineral deposit, were sent to London for investigation and comparison with *iroko* (*Chlorophora excelsa*—African teak).

At the suggestion of the Principal Forest Officer, Federated Shan States, that it might be possible to obtain by distillation of *Pinus khasya* wood a product similar to the " Pintar " derived from *Pinus longifolia* and described in *The Indian Forester* for July, 1931, the matter was taken up with Professor D. H. Peacock of the Chemistry Department, Rangoon University. It was arranged first to carry out distillation on a small scale in glass or iron vessels at the University and later to design a retort which will deal with say, ½ to 1 cwt., and have it built and operated at the Ahlone Depot. It is proposed to work out easily reproducible conditions of distillation and send the product to the Principal Forest Officer for trial. The most likely use for it appears to be as a wood preservative. Raw material required for the small scale experiment was obtained from the Principal Forest Officer and handed over to Professor Peacock.

(6) *Paper Pulp.*

As a measure of economy the sample plots of *kayinwa* (*Melocanna bambusoides*) in the old South Arakan division were abandoned during the year under report. It is hoped that experiments carried out on

the sample plots in North Arakan division will give information regarding the regrowth of this species after felling under varying conditions.

(7) *Tans.*

Nil.

(8) *Woodworking.*

The details of work under this head are given in the Annual Report of the Timber Research division. Only the broader aspects are described here. The saw-mill was closed throughout the year, logs being cut in outside mills when required, and the frame-saw being used in the re-sawing of flitches.

The workshop handled 29 timbers, which are listed below in descending order of importance.

Major Attention.

Constructional—

1. *Thingan* (*Hopea odorata*).

Industrial—

1. *Mau-lettan-she* (*Anthocephalus cadamba*).
2. *Baing* (*Tetrameles nudiflora*).
3. *Didu* (*Bombax insigne*).
4. *Letpan* (*Bombax malabaricum*).
5. *Yon* (*Anogeissus acuminata*).
6. *Hnaw* (*Adina cordifolia*).
7. *Yemane* (*Gmelina arborea*).
8. *Panga* (*Terminalia chebula*).
9. *Thikado* (*Cedrela toona*).
10. *Thitmin* (*Podocarpus wallichianus*).
11. *Gyo* (*Schliechera trijuga*).
12. *Gangaw* (*Mesua ferrea*).
13. *Binga* (*Mitragyna diversifolia*).
14. *Taungthayet* (*Swintonia floribunda*).
15. *Hmanthin* (*Cinnamomum* sp.).

Furniture—

1. *Yinma* (*Chukrasia tabularis*).
2. *Kyana* (*Carapa moluccensis*).
3. *Padauk* (*Pterocarpus macrocarpus*).

4. *Taukkyan* (*Terminalia tomentosa*).
5. *Sit* (*Albizzia procera*).
6. *Tamalan* (*Dalbergia oliveri*).
7. *Sandawa* (*Cordia fragrantissima*).
8. *Maniawga* (*Carallia lucida*).
9. Oak (*Quercus* spp.).
10. *Thitka* (*Pentace burmanica*).
11. *Chay* (*Gluta tavoyana*).

Minor Attention.

Constructional—

1. *Pyinma* (*Lagerstroemia flos-reginae*).
2. Teak (*Tectona grandis*).

The tonnage of furniture woods used was only half that of last year, there being a falling off in orders owing to the general shortage of money. *Padauk, yinma, kyana* and *taukkyan* were the timbers most in demand.

Parquet flooring in *padauk* and *sit* was sold to the value of Rs. 1,444. *Hnaw* (*Adina cordifolia*) and *binga* (*Mitragyna diversifolia*), chiefly the former, were in good demand for printing blocks, but there was an all round fall in other orders, due chiefly to the depression in trade. The manufacture of hammer handles, for which well-seasoned *yon* (*Anogeissus acuminata*) has shown itself most satisfactory, has been taken up by outsiders. Some of their products have, however, been made of green timber and have proved useless, a failure which has done our trade in these articles a certain amount of harm.

The workshop used 680 tons of timber, compared with 392 tons in 1931-32 and 393 tons in 1930-31. Box-shooks and sawn "dunnage", supplied principally to Messrs. The Burmah Oil Co., Ltd., account for 345 tons, there being a considerable decrease in the output of both furniture and other articles. The workshop waste was 36 per cent., a satisfactory figure, particularly when it is borne in mind that—

(1) owing to the lack of a re-saw much timber of second grade quality had to be taken on charge,

(2) box-woods were taken over at green measurements, so shrinkage during drying appears as workshop waste.

The revenue from the workshop was Rs. 76,724, a big drop from the figure of Rs. 1,03,414 recorded last year, though sales to be public increased from Rs. 55,782 in 1931-32 to Rs. 65,096, the decrease in total revenue being due to the practical cessation of work for other Government departments.

In the first few months of the year further developments took place in connection with the manufacture of box-shooks from *mau-lettan-she* (*Anthocephalus cadamba*). Bulk orders were executed in this timber, and careful analysis of the results was published in Economic Series Pamphlet No. 7, "Note on the use of Burmese Timbers for the Manufacture of Box-shooks and Packing Cases", by A. N. Barker, Divisional Forest Officer, Timber Research division. It was found possible to produce boxes at a price comparable with those quoted for imported Japanese conifers if the expense of kiln-seasoning were eliminated. This could be achieved on a very large scale by carrying out all conversion and manufacture in the dry zone of Burma, where no artificial seasoning apparatus would be necessary.

Of timbers other than *mau-lettan-she*, *letpan* (*Bombax malabaricum*) and *didu* (*B. insigne*), though regarded less favourably than *mau-lettan-she* owing to their slight colour, were accepted as substitutes.

Boxes of green *baing* (*Tetrameles nudiflora*) supplied to Messrs. C. R. Cowie & Co., are reported to have behaved very well, there being no warping after a period of seven months; wire nails placed inside them showed practically no signs of rusting. After the close of the year Messrs. The Burmah Oil Co., Ltd., reported losses in their stores of box-shooks made of Burma woods, owing to the attacks of borers and decay.

An enquiry was received for samples of timbers suitable for shuttle-making. At the request of a Bombay firm, samples of *pyingado* (*Xylia dolabriformis*) and *myaukchaw* (*Homalium tomentosum*) were sent to their German agents for tests of their suitability, but they have not yet been reported on. A sample of *hnaw* (*Adina cordifolia*), which is considered much more appropriate for the purpose than either *pyingado* or *myaukchaw*, was also sent.

At the instance of the Chief Education Officer, Federated Shan States, Taunggyi, samples of the following timbers were sent to a skilful carver at Mongnai, Southern Shan States:—

Kyana (*Carapa moluccensis*).

Thitmin (*Podocarpus wallichianus*).

Hnaw (*Adina cordifolia*).

Tamalan (*Dalbergia oliveri*).

Thinwin (*Millettia pendula*).

This craftsman makes excellent painted figures of teak wood, and his views on the qualities of these new timbers are awaited.

The Deputy Director of Agriculture, Tenasserim Circle, Moulmein, was supplied with small barrels of *yemane* (*Gmelina arborea*) and *thitmin* (*Podocarpus wallichianus*) for experiments on the storage of palm oil. As it is essential that the wood used for making casks should not conta-

minate the oil, a sample was placed in contact with shavings of the two timbers under test for about ten days. Neither had any apparent affect on the colour or taste of the oil, but the report of their behaviour under service conditions has not yet been received.

An enquiry was received from the Karachi Port Trust for boat-hook staves of indigenous timber in place of imported ash. *Yon* (*Anogeissus acuminata*), which is about 35 per cent. heavier than ash, was suggested by the Trust, but the sample piece was found heavy, and our suggestion of *thitmin* (*Podocarpus wallichianus*) was accepted. Though no strength tests have yet been done *thitmin* has been found by experience to be strong and elastic and it has given very good service as aeroplane spars. A sample lot of 25 boat-hook staves were supplied to the Karachi Port Trust and the order was repeated just after the close of the year.

Samples of *hnaw* (*Adina cordifolia*) for pencils and *yinma* (*Chukrasia tabularis*), *thitka* (*Pentace burmanica*) and *thitmin* (*Podocarpus wallichianus*) for pen-holders, were sent to a firm in Calcutta and a report on their suitability is awaited.

(9) *Miscellaneous.*

(*i*) *Efforts to increase the sales of Burma timbers other than teak.*

There were many enquiries from the Timber Adviser to the High Commissioner for India, London, for quotations for Burmese hardwoods including *thitka* (*Pentace burmanica*), *kokko* (*Albizzia lebbek*), *thitkado* (*Cedrela toona*), and *taukkyan* (*Terminalia tomentosa*). Unfortunately no orders were received. The small trader whom it is desired to encourage has not usually the financial backing to deal with an export order, payment for which may be delayed several months. Financial stringency prevents the Timber Research division participating in the market or assisting traders with funds, and all that can now be done is to put the buyer in touch with reliable contractors and, if necessary, pass the timber.

An enquiry was received from Messrs. The Burmah Oil Co., Ltd., for timber suitable for water cooling towers. The essential qualities of timber employed for this purpose are steadiness, strength, durability, especially resistance to termites, and freedom from warping and twisting. A reasonably cheap Burma timber possessing all these qualities and suggested as likely to prove suitable for this purpose was *thingan* (*Hopea odorata*). Our quotations were, however, undercut by suppliers of treated timbers in other parts of the Empire.

Investigations into the possibilities of an Indian market for Burma softwoods were set on foot by a timber merchant from Madras, but he eventually announced that he was not, in the present uncertain political situation, prepared to finance the venture.

During the year arrangements were made to supply one ton of seasoned *yindaik* (*Dalbergia cultrata*) 2″×2″ scantlings for the manufacture of musical instruments. Carefully selected black heart-wood timber was obtained from Moulmein, but seasoning was not complete by the end of the year. Arrangements were also made to put reliable traders into touch with Messrs. The Burma Corporation, Ltd., Namtu, for the supply of special-size *pyingado* (*Xylia dolabriformis*) for use as shaft guides in their mine.

Efforts were made to secure the acceptance by the Board of Trade of Burma *padauk* (*Pterocarpus macrocarpus*) for the frame timbers of ships' life boats. On the average, *padauk* is 25 per cent. heavier than teak, but it is also stronger, its special virtue being its power of resistance to shock. *Padauk* is superior to teak in every property except steadiness—under given conditions it is liable to shrink or swell 10 per cent. more than teak. Even so it is exceptionally steady and moves very much less than oak under similar circumstances. Experiments in bending *padauk* at the Government Timber Depot and the Government Dockyard, revealed that this timber is eminently suitable for boat-building. Samples of *padauk* were supplied to Messrs. The British India Steam Navigation Co., Ltd., for tests and further report is awaited.

(*ii*) *Comparative counts of bee-holes made by the moth Xyleutes* (*Duomitus*) *ceramicus in teak from various localities.*

Burma Forest Bulletin No. 29, entitled "Measurements of the Damage to Teak Timber by the Beehole Borer Moth, *Xyleutes* (*Duomitus*) *ceramicus* with special reference to relative severity in Plantations and Natural Forests, and to variation to rainfall and position in the tree," was published during the year and distributed to those likely to be interested. It describes in detail the work started in 1926, and commented upon in previous reports.

(*iii*) *Experiments on the specific resistance to teredo attack of various timbers.*

No further experimental work in connection with resistance to teredo has been done during the year, but our experience was placed at the disposal of the Admiralty and Public Works Department (Irrigation Branch) in connection with specific problems.

The Borneo timber, *billian*, referred to in last year's report, was identified as *Eusideroxylon zwageri* (*Lauraceae*). It is a species with a high reputation for resistance to marine organisms in tropical waters.

(*iv*) *Timber Passing.*

During the year under report a consignment of *papita* (*Sterculia campanulata*) and *dhup* (*Canarium* spp.) match-wood logs under dispute

between the Chief Forest Officer, Port Blair, Andamans, and Messrs. The Burma Match Co., Ltd., was surveyed at the request of both parties and a report submitted to the former.

A small parcel of sample sleepers of teak and *pyingado* (*Xylia dolabriformis*), submitted by a contractor for supply to the Egyptian Railways, was also inspected and certified.

Arrangements were made with the Divisional Forest Officer, Kado and Agency division, Moulmein, to inspect and pass about 500 first class special-size *pyingado* sleepers under shipment to Chittagong by a Rangoon firm.

(v) *Enquiries and liaison.*

The usual number of miscellaneous enquiries were dealt with. The usual liaison was maintained with other specialists in Burma and with the Forest Research Institute. There was also co-operation with the Timber Advisory Officer, Railway Board, India; the Director of the Forest Products Research Laboratory, Princes Risborough, Bucks, England; the Imperial Institute, London, and the Timber Adviser to the High Commissioner for India, London.

Technical journals, bulletins and other publications from England, America, Canada, Australia, South Africa and elsewhere were found very useful. Special attention was directed to literature on the grading of timber and a full and representative collection of books and pamphlets published in Europe and America has been built up. It is thought that these may prove helpful in the marketting of Burma timbers.

CENTRAL PROVINCES.

(1) *Experimental.*

Nil.

(2) *Minor Produce.*

Lac.—The crop has shown no appreciable recovery from the damage sustained through the severe heat of 1931. Furthermore, the lack of demand and fall in prices did not offer any inducement to the extension of lac propagation. In several divisions, departmental work was abandoned as it was found that the selling price was lower than the cost of production. In Murwara range of Jubbulpore division, lac has disappeared as a result of the severe frost in January 1933.

In the statement given below, the yield obtained is compared with that of the previous year :—

Name of division	Lac collected.	
	1932-33.	1931-32.
	Md.	Md.
Damoh	543	537
Bilaspur	6	18
Saugor	116	48
Raipur	430	476
Bhandara	29	50
Chhindwara	..	12
Jubbulpore	..	27
Seoni	174	85
Hoshangabad	..	11
Total	1,299	1,267

T. N. prices fell from Rs. 20 in the year 1931-32 to Rs. 17-8 during the year under report.

Revenue from this source during the year has been as under :—

	Rs.
Eastern Circle	11,108
Central Circle	1,665
Western Circle	152
Total	12,925

against Rs. 16,722 in the previous year.

Myrobalans.—The prices prevailing during the year in the Calcutta market are given below :—

	March 1931.	March 1932.	July 1932.	September 1932.	December 1932.	March 1933.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Jubbulpore average	1·14	2·3	2·0	2·10	2·8	1·14
Jubbulpore No. 1	2·5	2·10	2·6	3·4	2·14	2·6
Crushed No. 1	3·4	4·0	4·4	4·8	3·14	3·6

Nearly 70,000 maunds of myrobalans were collected in Balaghat, which is a normal crop : elsewhere the crop was only 50 per cent of the normal. High prices ruled throughout the year and myrobalans were exported in large quantities. From Bombay alone 684,500 cwts. were exported during the year.

If the departmental collections of *harra* had been continued, it is estimated that a net profit of about Rs. 40,000 might have been realised from Balaghat division alone.

Rusa oil.—A further decline in receipts from Rs. 4,185 to Rs. 3,798 indicates that this industry is moribund.

Tendu leaves.—There has not been any increase in the export of *tendu* (*Diospcros*) leaves despite the fact that the *birri* industry is developing. The reason is that the bulk of the demand can be met from *rayatwari* and *malguzari* forests. The revenue from this source is therefore falling in almost every division.

Katha (*Acacia catechu*).—Demand for *katha* continued to be brisk and the rights of manufacture were leased at Rs. 19-10 per handi in Damoh, Rs. 14-12 to Rs. 19-6 in Saugor and Rs. 11 in Jubbulpore. The total revenue realised is detailed below :—

	Rs.
Damoh	3,042
Saugor	2,455
Jubbulpore	3,117
Mandla	7,054
Seoni	4,150
TOTAL	19,818

Gum karaya.—This gum which is exuded from the *kulu* tree (*Sterculia urens*) has continued in demand. 37,741 cwts. were exported to foreign countries from Bombay. Leases to the value of Rs. 5,000 were given in Damoh and Jubbulpore divisions.

Horns.—The slackness in demand still continues. Small quantities of horns were collected in certain divisions but could not be sold owing to lack of demand.

(3) *Commercial Activities.*

Notwithstanding the serious depression which prevailed throughout the year, departmental exploitation of teak was expanded in the Melghat and Nimar divisions while similar operations in Hoshangabad were repeated on the same scale as previously.

In all these divisions hand sawing on a small scale was started. Small lengths, butt ends and top pieces were converted by the saw, with the result that fixed sizes could not be arranged for. The total quantity of sawn material amounted to 8,098 c. ft., which found a ready sale at an average price of Rs. 1-3-6 per c. ft., against Rs. 0-13-11 per c. ft. obtained for axe-dressed timber. The advantages secured were :—

(*a*) the inferior quality timber which would otherwise have been wasted was utilised,

(*b*) timber pieces of short lengths could be exploited at a profit,

(*c*) wastage in dressing was saved, as side slabs found a sale.

Expenditure per cubic foot in sawing is somewhat higher than conversion with the adze, but profits are much higher. Hoshangabad division figures show that sawing charges were As. 2-6 per c. ft. against

As. 2 per c. ft. for conversion by the adze, and the increase in wastage was not important. The extension of sawing operations is likely to prove of great financial benefit. In Hoshangabad, a five year scheme has been introduced as a result of which it is hoped eventually to convert all timber with the saw.

In Raipur division, saleable logs and poles from material felled in regeneration fellings and thinnings were supplied to contractors on order and were also sold retail in the depots at Bagleyganj and Raipur city. Revenue from this source during the year amounted to Rs. 12,263. Firewood sales in Raipur city have received a set back owing to competition. 1,700 maunds of charcoal were manufactured during the year and successful experiments were made with the pit type of kiln.

The Bengal Timber Trading Company having completed their contract in Mandla division, departmental conversion of sleepers was undertaken for the first time in those forests.

A form of contract not previously undertaken was that for the supply of 16,000 broad gauge wagon floor boards : the order was completed within a period of three months.

(4) *Departmental teak depots.*

With the object of co-ordinating sales and freeing the divisional staffs from the responsibility of selling the timber, the periodical auctions at Ellichpur, Khirkiya, Timarni and Taku were all held by the Forest Utilisation Officer. The local officers were thus left free to attend to forest inspections while advantage could be taken of the Utilisation Officer's greater knowledge of market conditions and of his business connections with possible purchasers in various parts of the country.

Sales completed during the year through the agency of the Utilisation branch are shown below :—

——	1932-33.	1931-32.	Difference.
	Rs.	Rs.	Rs.
Gun Carriage Factory	..	5,591	—5,591
Great Indian Peninsular Railway	6,654	6,541	+113
Government Handicraft School, Nagpur	..	62	—62
Principal, Government Engineering School, Nagpur	224	..	+224
Head Master, Craddock High School, Wardha	39	..	+39
Head Master, School of Handicraft, Akola	300	..	+300
Superintendent, Central Jail, Nagpur	1,156	..	+1,156
Berar Victoria Technical Industrial Society, Amraoti	1,754	..	+1,754
Mint Master, Hyderabad (Deccan)	..	14,682	—14,682
N. S. Railway	40,738	37,574	+3,164
Sales on supply orders and invoices	168,002	133,561	+34,441
Auction sales	210,065	166,994	+43,071
TOTAL BALHARSHAH SALES	428,932	365,005	+63,927

—	1932-33.	1931-32.	Difference.
	Rs.	Rs.	Rs.
Sleeper contracts—			
Broad gauge . . 15,500	116,187	144,388	—26,138
Meter gauge . . 7,000	2,063		
Narrow gauge . { 17,000 / 1,500 }			
16,000 Wagon Floor Boards	20,000	..	+20,000
Rejected sleepers 906	4,217	4,053	+164
Pit props 3,311/2/3			
Bamboos	137	..	+137
Teak bullies	478	..	+478
Auction sale of timber in depots at Taku, Timarni, Khirkiya and Ellichpur, Western Circle	210,098	..	+210,098
Harra, etc.	..	17,700	—17,700
TOTAL .	353,180	166,141	+187,039
GRAND TOTAL .	782,112	531,146	+250,966

The usefulness of the utilisation branch is indicated by the numerous sales on supply order which were arranged with various Government departments. In consequence of a change of policy in Hyderabad, the Mint Master of the Nizam's State did not place any direct orders with the department during the year but purchased his requirements from local contractors who had, however, obtained their supplies from the Central Provinces.

In consequence of retrenchment, the Gun Carriage Factory, Jubbulpore, made no purchases from the department but secured its requirements at cheaper rates from contractors.

Balharshah Depot.—Sales to the public exceeded the sales of the previous year by over Rs. 77,000. This increase was partly off-set by the fact that no orders were placed either by the Gun Carriage Factory or the Great Indian Peninsular Railway who obtained their supplies at lower rates from contractors. In consequence, it was necessary to sell large stocks of timber at the periodical auctions.

Total sales during the year amounted to Rs. 4,28,932 against Rs. 3,65,005 in the previous year.

Details exclusively for teak are :—

	C. ft.	Amount.	Average.	Previous year.
		Rs.	Rs. A. P.	Rs. A. P.
Logs	215,474	2,46,516	1 2 1	1 6 0
Sawn	82,110	1,60,952	1 15 4	1 14 9

The price of logs depreciated because timber down to a lower grade was exported to Balharshah during the year. The slight increase in the rate for sawn timber is due to the booking of advance orders.

The Timber Transport Company transported 284,862 c. ft. of timber during the year and their work was very satisfactory.

MADRAS.

(1) *General Work of administration.*

The Forest Utilization Officer continued to organise sales of logs, scantlings, sleepers and minor forest produce, and was in charge of disposals from the depots of the more important timber divisions of South Coimbatore, Nilambur and the Wynaad. Advice was given to local officers and to the public. Trial consignments of timber for test in the Forest Research Institute, Dehra Dun, were organised.

(2) *Experimental and commercial activities.*

Experimental activities (*1*) *Timber testing.*—Samples were sent to the Forest Research Institute for test under the various projects. Arrangements were also made to supply specimens of the following soft woods from the South Kurnool division to the Madras Pencil Factory for experiments on their suitability for pencils.

Givvotia rottleriformis

Garuga pinnata

Gyrocarpus jacquini

Odina wodier

Boswellia serrata

Sterculia urens.

A joint inspection with an officer of the South Indian Railway of untreated experimental sleepers of *Poeciloneuron indicum* was made by the Forest Utilization Officer and the results were communicated to the Forest Research Institute.

(2) *Wood Preservation.*—Ten metre gauge sleepers of *Callophyllum tomentosum, Callophyllum wightianum, Hopea parviflora, Lagerstroemia lanceolata,* and *Xylia xylocarpa* were sent to the Forest Research Institute for special experiments to collect data relative to the treatment of the sapwood of these species.

(3) *Commercial activities.*

(1) *Sleepers.*—A supply of 39,276 broad gauge and 27,026 metre gauge hardwood sleepers (*Mesua ferrea, Xylia xylocarpa* and *Hopea parviflora*) was organised and passed by the Forest Research Officer.

An experiment was also made in rendering split sleepers serviceable by fixing iron bolts at their ends. 1,000 broad gauge sleepers repaired

in this manner have been supplied and are being used in the line by the Madras and Southern Mahratta Railway. Results are awaited.

Two years' supply of special size teak sleepers has been arranged with the South Indian Railway as well as the supply of 51 tons of teak in the log ; 75 tons of teak logs have also been sent to the Madras and Southern Mahratta Railway.

(2) *Special orders and overseas trade.*—3,500 c.ft. of *Grewia tilaefolia* was supplied to the Gun Carriage Factory, Jubbulpore.

The demand for laurel (*Terminalia tomentosa*) in the overseas market showed a tendency to increase, and 3,000 c.ft. of it were supplied to a firm in England through the Timber Advisor to the High Commissioner for India. Further orders are materialising.

(3) *Timber market.*—The general slump in prices continued, but a hopeful feature was that the demand, though still below the normal, was on the increase.

The following are the chief Madras timbers in the order of demand.

Teak (*Tectona grandis*).
Indian rosewood (*Dalbergia latifolia*)
Irul (*Xylia xylocarpa*) for sleepers
Kindal (*Terminalia paniculata*)
Laurel (*Terminalia tomentosa*)
Benteak (*Lagerstroemia lanceolata*)
Bijasal (*Pterocarpus marsupium*)
Dhaman (*Grewia tilaefolia*)
Toon (*Cedrela* spp.) for cigar boxes
Semul (*Bombax malabaricum*) for matches

and a few other miscellaneous softwood species for pencil making.

The price of good teak and rosewood logs ranged from Rs. 2-8-0 to Rs. 3 per cubic foot and that for average quality miscellaneous species from annas ten to annas fourteen per cubic foot.

The total value of the sales made by the Forest Utilization Officer increased to Rs. 9,60,000 as against Rs. 7,94,000 in the previous year.

(4) *Minor Forest Produce.*

(1) *Nux vomica.*—Experiments with seeds collected from the east and west coasts of the presidency were conducted by the Forest Research Institute in 1931 and the results disclosed that the quality does not deteriorate under varying storage conditions.

Further experiments were made by the Forest Research Institute with seeds collected from different districts on the east coast. Results

have been satisfactory. Temporarily the demand for *Nux vomica* has dwindled and it was with great difficulty that the accumulated stocks of the Nellore division were disposed of at so low a price as Rs. 10 per candy of 500 lbs.

(2) *Tans—Cassia auriculata.*—For the systematic examination of this valuable tan bark from plants of varying ages, and growing on different soils, plantations were formed in three divisions—Anantapur, Vizagapatam and Nellore.

(3) *Lac.*—Experiments in lac had been carried out in previous years in North Salem, Madura, North Coimbatore, Central Salem and Palghat. Successful crops were raised in all these districts except North Coimbatore. *Kusum* brood on *Schleichera trijuga* in Madura and Palghat, and Mysore brood on *Shorea talura* in North and Central Salem gave encouraging results. As the market for lac is exceptionally dull and as the demand for it is limited and occasional, it was decided to stop further cultivation in Palghat, Central Salem, and North Coimbatore and to carry it on only on a limited scale in North Salem and Madura, mainly with a view to conserve and develop existing broods. About a ton of washed grain lac obtained from the experimental cultivation is now in stock. Departmental manufacture of shellac, scaling wax, and wood polish has been tried on an experimental scale and is still under examination.

Enquiries and Liaison.—The usual number of miscellaneous enquiries were dealt with and liaison was maintained with other specialists in the presidency and at the Forest Research Institute. There was also cooperation with the Timber Advisory Officer, Railway Board, India, the Forest Products Research Laboratory, Princes Risborough, Bucks, England, the Timber Advisor to the High Commissioner for India, London, and the Indian Trade Commissioner, Hamburg.

PUNJAB.

(1) *Timber seasoning.*

Stacking of sleepers in sale depots.—Stacking experiments with *chil* (*Pinus longifolia*) were repeated in Jhelum sale depot. 1 and 9 method of stacking, with proper protection on the top and sides, again gave the highest passing percentage, *viz.*, 58·4 per cent.

(2) *Minor Forest Produce.*

Lac cultivation.—The lac cultivation experiments being carried out in Hoshiarpur and Rawalpindi East Forest divisions suffered a set back on account of severe drought and doubtful quality of seed used for inoculation.

Cultivation of bhabar (*Ischaemum angustifolium*) *grass.*—7 experimental plots were started during the year in Kalesar reserved forest, Simla Forest division, to study the propagation, development and yield of *bhabar* grass on different slopes and aspects, with and without overhead cover, ground vegetation and grazing.

Cultivation of kuth (*Saussurea lappa*).—A small quantity of *kuth* seed was sown experimentally in Kumarsain and Balsan States and Dukani orchards, Simla Forest division. The seed has germinated well and the experiment holds out hopes of success.

Ephedra.—Available quantities of *Ephedra* in Muzaffargarh (Multan Forest division) *rakhs* were estimated. About 400 maunds per annum could be collected from that locality.

UNITED PROVINCES.

(1) *General.*

An almost inevitable consequence of the closure of the Utilisation division, mentioned in the last year's report, has been that there has been practically no research work or experiments in utilisation carried out during the year. A few remarks may however be of interest as regards the general market for forest produce.

The timber market appeared at the time of annual auctions to indicate possibility of slight recovery, but prices ruled low during the year and even fell a little towards the end of the season.

Railway requirements of *sal* sleepers were again comparatively small and only the Tarai Group placed orders for the direct supply of meter gauge *sal* sleepers to the Bengal North-Western Railway and Rohilkhand and Kumaon Railway.

Despite relatively poor market conditions the outturn of *sal* timber increased from about 3,900,000 c. ft. to 4,200,000 c. ft. and was mostly absorbed by the market with no serious increase of stock, in hand. Similarly the outturn of chir timber increased from 1,200,000 c. ft. to 1,300,000 c. ft. and was absorbed by the market. *Semal* (*Bombax malabaricum*) timber for the match industry increased from 28,000 c. ft. to 76,000 c. ft., while deodar (*Cedrus deodara*) increased from 31,000 c. ft. to 138,000 c. ft. These satisfactory results had an important influence on the financial results of forest administration in the United Provinces and were the principal cause of a surplus of over Rs. 20,00,000 in the financial year 1932-33. The sustained demand in the United Provinces is all the more remarkable by comparison with the apparent fall in demand in most other provinces in India. A possible explanation is that the demand for timber and fuel in the United Provinces is entirely local and hence less effected by the world depression.

(2) *Minor Forest Produce.*

The most important item of minor produce is resin and the resin industry in Kumaon produced over 87,000 mds. of resin as compared with 66,000 mds. last year. The surplus of the year from the resin industry was Rs. 1,84,000 as compared to Rs. 1,65,000 last year. It is interesting to note that in the last ten years Government have received over Rs. 50,00,000 in cash from the resin industry and during this period the direct expenditure has been some Rs. 30,00,000, a large proportion of which is in the form of wages disbursed in Kumaon. These figures indicate the value of the industry both for the province and Kumaon.

CHAPTER VI.—FOREST CHEMISTRY.

PUNJAB.

All soil samples taken in Changa Manga plantation during the year in connection with the determination of the relative loss of water from soils under different cover were analysed at the Forest Research Institute for moisture contents.

Hydrogen-ion concentration values of 90 soil samples taken last year for every 6″ depth down to 2½′ in different types of vegetation in spruce, silver fir and *kail* forests in the Kulu division were found by the electrometric method at the Punjab Irrigation Research Institute. The Director of the Institute has kindly allowed the investigations to be continued and results will be reported in due course. Soil samples from Khanewal plantation were also analysed, and poorness of growth is attributed to high hydrogen-ion concentration (high degree of alkalinity); the remedial measures so far suggested are, however, impracticable.

APPENDIX I.

List of Provincial Forest Publications of 1932-33 (excluding the Forest Research Institute Publications).

ASSAM.

Indian Forester Articles:

The utility of the Cachar bamboos. A. K. Adhikari.

Scrap the lot; (replacing mixed natural forest with *taungya*). W. R. Martin.

Furniture from indigenous timber of Cachar. A. K. Adhikari.

Relation between fire and creepers in *sal* forest. R. N. De.

Notes on present shellac market. A. K. Adhikari.

BENGAL.

Indian Forester:

Identification of the *garjans* in Cox's Bazar division. R. I. Macalpine.

Rate of growth of elephant calves. A. K. Glasson.

Relation between fire and climbers in *sal* forest. V. S. Rao.

BIHAR AND ORISSA.

Indian Forester: Afforesting abandoned paddy fields. L. R. Sabharwal.

BOMBAY.

Forest Engineering books:

Standard forest roads, cross sections, and earth-work tables by T. S. Pipe.

Standard type buildings for the Forest Department, Bombay Presidency, by T. S. Pipe.

Indian Forester:

Succession among the grasses of the Deccan trap dry mixed deciduous formation and its use in sub-classification. E. A. Garland.

An ecological classification. E. A. Garland.

Government sawmills in Bombay Presidency. T. K. Mirchandani.

Forest soils. E. A. Garland.

BURMA.

Forest Bulletin No. 29.—Measurements of the damage to teak timber by the beehole borer moth, *Xyleutes* (*Duomitus*) *ceramicus*, by C. W. Scott.

Forest Bulletin No. 30.—Photographs of the timbers of Burma as seen through a hand lens (×10).

Note on *pyinkado* (*Xylia dolabriformis*), by F. Allsop (Economic Series, Pamphlet No. 8).

Indian Forester: Burma forest soils. A. H. M. Barrington.

CENTRAL PROVINCES.

Indian Forester:

Tephrosia candida experiments in Central Provinces. Tara Singh.

Notes on regeneration technique in Central Provinces. Tara Singh.

Game preservation in the Central Provinces and Berar. Tara Singh.

Hardwickia binata coppice reproduction. Tara Singh.

Eradication of *Lantana* with elephants. V. K. Maitland.

MADRAS.

Rules regarding selection, felling, cleaning, classification and disposal of sandal wood and the method of maintaining depot accounts and their registers.

Indian Forester:

The *sholas* of Palghat division.—A study in the ecology and silviculture of the Tropical Rain Forests of Western Ghats. V. T. T. Aiyar (awarded Brandis prize).

Study of spectrum in the choice of species. N. Trimurti.

PUNJAB.

Forest Leaflet No. 7.—Special forest maps.

Forest Leaflet No. 8.—Fire protection.

Forest Leaflet No. 11.—Working plans.

Proceedings of the Punjab Forest Conference, 1933:—

A study in the ecology and silviculture of the Himalayan spruce (*Picea morinda*) and silver fir (*Abies pindrow*) with special reference to works in progress in Kulu, by Parma Nand Suri.

Ecology of *Pinus longifolia* with particular reference to Kangra and Hoshiarpur forest divisions, by N. P. Mohan.

A preliminary note on the cultivation of *farash* (*Tamarix articulata*, Vahl.), by Parma Nand Suri and Ram Saran Chopra.

Gravity ropeways with comparison of the Donald and Bicable systems for the extraction of timber in the Punjab Hills, by E. Owen Williams.

Indian Forester:

Nursery experiments with spruce seed. K. L. Aggarwal.

Control measures for protection of *Pinus longifolia*. Khan Sahib Allah Bakhsh.

Financial forecast for an irrigated plantation. Sardar Sahib Bahadur Singh.

Eucalyptus cultivation in Changa Manga plantation. Fazal Mohd. Khan.

Recent changes in forest management in Himalayan coniferous forests, with special reference to the shelterwood compartment system. H. M. Glover.

Regeneration of silver fir. Jalmeja Singh.

UNITED PROVINCES.

Indian Forester:

Sal and its regeneration in the United Provinces. E. A. Smythies. (Awarded Schlich prize).

Ramnagar Regeneration Fellings. W. A. Bailey.

Panchayat Forests in Kumaon. A. E. Osmaston.

Silvicultural systems for *sal* in the United Provinces. E. A. Smythies.

Air survey of forests. F. W. Champion.

Financial prospects of departmental *taungya* in Haldwani, United Provinces. D. Stewart.

APPENDIX II.

Statement showing rank, designation and address of Forest Officers employed exclusively on research work in the various Provinces during the year 1932-33.

Serial No.	Name.	Designation.	Address.
1	Mr. A. Das, Deputy Conservator of Forests.	Attached to the Direction Division on special duty, Assam.	Shillong.
2	Mr. T. M. Coffey, Deputy Conservator of Forests.	Forest Utilization Officer, Bengal.	Darjeeling.
3	Mr. C. K. Homfray, Deputy Conservator of Forests.	Divisional Forest Officer, Silvicultural Division, Bengal.	Do.
4	Mr. J. N. Sen Gupta, Extra Assistant Conservator of Forests.	Range Officer, Southern Range of the Silvicultural Division, Bengal.	Chittagong.
5	Mr. B. P. Basu, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa.	Ranchi.
6	Mr. F. Allsop, Deputy Conservator of Forests.	Forest Economist, Burma	Rangoon.
7	Mr. R. W. V. Palmer, Deputy Conservator of Forests.	Silviculturist, Burma .	Maymyo.
8	Mr. Tara Singh, Deputy Conservator of Forests.	Silviculturist, Central Provinces, from 1st April 1932 to 30th September 1932.	Balaghat.
9	Mr. H. S. George, Deputy Conservator of Forests.	Silviculturist, Central Provinces, from 1st October 1932 to 31st March 1933.	Nagpur.
10	Mr. W. G. Dyson, Deputy Conservator of Forests.	Silviculturist, Madras .	Ootacamund
11	Mr. Parma Nand Suri, Extra Assistant Conservator of Forests.	Divisional Forest Officer, Silvicultural Research Division, Punjab.	Lahore.
12	Mr. Ram Saran Chopra, Extra Assistant Conservator of Forests.	Assistant to the Divisional Forest Officer, Silvicultural Research Division, Punjab.	Do.
13	Mr. F. C. Ford Robertson, Deputy Conservator of Forests.	Silviculturist, United Provinces, (for part of the year).	Naini Tal.
14	Mr. E. C. Mobbs, Deputy Conservator of Forests.	Silviculturist, United Provinces (for rest of the year).	Do.
15	Mr. Sohan Singh Negi, Extra Assistant Conservator of Forests.	Assistant Silviculturist, United Provinces	Do.

APPENDIX III.

Publications of the Forest Research Institute, Dehra Dun, available for sale.

	Price (exclusive of packing, postage, etc.). Rs. A. P.
I.—BULLETINS (OLD SERIES).	
4. *Ficus elastica*: its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Conventry	0 12 0
6. Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
II.—LEAFLETS—(All out of print).	
III.—PAMPHLETS.	
6. Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	1 0 0
8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia	0 10 0
9. Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author	0 10 0
10. Note on Burmese Leza Wood (*Lagerstroemia tomentosa*, Presl.), by R. S. Troup	0 2 0
16. Note on the Best Season for Coppice Fellings of Teak (*Tectona grandis*), by R. S. Hole	0 4 0
IV.—BULLETINS (NEW SERIES).	
3. Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0 4 0
6. Memorandum on the Oil-Value of Sandalwood, by Puran Singh	0 2 0
7. Note on the Chemistry and Trade Forms of Lac, by the same author	0 3 0
8. Note on some Germination Tests with Sal Seed (*Shorea robusta*), by R. S. Troup	0 2 0
9. Note on Resin-Value of *Podophyllum emodi* and the best season for collecting it, by Puran Singh	0 1 3
11. A Further Note on some Casuarina Insect Pests of Madras, by V. Subramania Iyer	0 14 0
13. Note on *Ligno Protector* as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0 5 0
14. A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0 3 0
15. Note on the Technical Properties of Timber with special reference to *Cedrela toona* wood while seasoning, by the same author.	0 3 0
*16. Note on Gumhar (*Gmelina arborea*, Roxb.), by A. Rodger	0 3 0
17. Note on Bija Sal or Vengai (*Pterocarpus marsupium*, Roxb.), by the same author	0 4 0
18. Note on Sain or Saj (*Terminalia tomentosa*, W. and A.), by the same author	0 5 0
19. Note on Benteak or Nana Wood (*Lagerstræmia lanceolata*, Wall.), by the same author	0 3 0
20. Note on Sandan (*Ougeinia dalbergioides*, Benth), by the same author	0 3 0
21. Note on Dhaura Bakli (*Anogeissus latifolia*, Wall.), by the same author	0 4 0

IV.—BULLETINS (NEW SERIES)—*contd.*

	Price (exclusive of packing, postage, etc.). Rs. A. P.
22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 0
23. Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Hole	0 4 0
24. Note on Turpentines of *Pinus khasya*, *Pinus merkusii* and *Pinus excelsa*, by Puran Singh	0 2 0
25. Development of the Culms of Grasses, by R. S. Hole	0 2 0
26. Note on the Resin Industry in Kumaun, by E. A. Smythies	1 4 0
27. Note on Blackwood (*Dalbergia latifolia*, Roxb.), by E. Benskin	0 4 0
28. Note on Dhauri (*Lagerstroemia parviflora*, Roxb.), by the same author	0 4 0
29. Note on Sundri Timber (*Heritiera minor*, Lam.), by R. S. Pearson	0 3 0
30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
31. Note on Indian Sumach (*Rhus cotinus*, Linn.), by Puran Singh	0 2 0
32. Note on the Burma Myrobalans or "Panga fruits" as a Tanning Material, by Puran Singh	0 1 0
33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
34. Note on Red Sanders (*Pterocarpus santalinus*, Linn. f.), by T. A. Whitehead	0 9 0
35. Note on Babul (*Acacia arabica*, Willd.), by J. D. Maitland-Kirwan	0 5 0
*36. Note on Kokan or Lampatia Timber (*Duabanga sonneratioides*, Ham.), by R. S. Pearson	0 3 0
37. Note on the Contraction and Warping which takes place in *Pinus longifolia* timber while seasoning, by the same author	0 11 0
38. The Construction of Calcareous Opercula by Longicorn Larvae of the Group *Cerambycini* (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
39. Note on Hollong Timber (*Dipterocarpus pilosus*, Roxb.), by R. S. Pearson	0 4 0
40. Note on Pyinma, Ajhar or Jarul Wood (*Lagerstroemia flos-reginea*, Retz.), by the same author	0 6 0
*41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion	0 8 0
42. Note on Haldu (*Adina cordifolia*, Hook, f.), by C. E. C. Cox	0 8 0
43. Note on *Odina wodier*, Roxb., by the same author	0 8 0
44. Note on Semal or Cotton Wood (*Bombax malabaricum*), by the same author	0 10 0
45. Note on the Miscellaneous Forests of the Kumaun Bhabar, by E. A. Smythies	1 0 0
46. Rate of Growth of Bengal Sal (*Shorea robusta*), I Quality, by S. H. Howard	1 0 0
47. Volume Tables and Form Factors for Sal (*Shorea robusta*), by the same author	0 6 0
48. Note on Kindal (*Terminalia paniculata*), by R. S. Pearson	0 6 0
*49. Note on Thingan (*Hopea odorata*, Roxb.), by A. Rodger	0 7 0
50. Note on Gurjun or Kanyin (*Dipterocarpus* Spp.), compiled by W. A. Rebertson.	0 4 0
51. An Investigation of certain factors concerning the Resin-tapping Industry in *Pinus longifolia*, by H. G. Champion	0 8 0
*56. A Report on the Tan Values of Indian Myrobalans and Burma *Terminalias*, by J. A. Pilgrim	0 6 0
*57. Tan Investigation of the Burma Hill Pine, *Pinus khasya* bark and *Pyinkado*, *Xylia dolabriformis*, by the same author	0 3 0
*58. General Volume Tables for *Chir* (*Pinus longifolia*), by S. H. Howard	0 8 0
*59. Summary of results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India, by J. H. Warr	1 14 0

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*61. Eucalyptus in the Plains of North-West India, by R. N. Parker	0 5 0
*62. Preliminary Yield Table for *Dalbergia sissoo*, by S. H. Howard	0 2 0
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*65. Tables for bark deductions from logs, by S. H. Howard	0 3 0
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*67. Chir (*Pinus longifolia*) Seed Supply, by S. H. Howard	0 3 0
*69. The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir, by L. N. Seaman, assisted by C. R. Ranganathan	1 1 0
*70. *Hoplocerambyx spinicornis*—An Important Pest of Sal, by D. J. Atkinson	0 15 0
*71. A List of Trade Names of Indian Timbers	0 5 0
*72. Instructions for the Operation of Timber Seasoning Kilns, by S. N. Kapur	1 12 0
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*80. List of Trees and Shrubs for the Kashmir and Jammu Forest Circles, by W. J. Lambert	0 12 0

V.—FOREST RECORDS.

Vol. II, Part III.—1. Monograph on the Silviculture of *Hardwikia binata* (*Anjan*), by D. O. Witt			3 4 0
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,, Part IV.—Note on Host Plants of the Sandal Tree, by the same author			2 0 0
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„	Part	V.—Note on *Trametes pini*, by the same author .	1 0 0
„	Part	VI.—Note on a New Species of Forest Grass (*Spodiopogon lacei*, Hole), by the same author . .	0 8 0
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„	Part	V.—Notes on the Larvæ and Life-Histories of Prionine Beetles, (Coleoptera, Cerambycidae, Prionini), by C. F. C. Beeson	0 8 0
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Vol.	IX, Part	II.—On Chalcidoidea (mainly bred at Dehra Dun, U. P., from pests of *Sal*, *Toon*, *Chir* and *Sundri*), by James Waterston	1 2 0
„	Part	III.—Oils and Fats from the Seeds of Indian Forest Trees, Parts I—V, by M. Gopal Rau and J. L. Simonsen	0 3 0
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* „	Part	VII.—Note on the Possibilities of Camphor Cultivation from *Cinnamomum camphora* in Northern India, by S. H. Howard, W. A. Robertson and J. L. Simonsen	1 4 0
* „	Part	VIII.—The Constituents of some Indian Essential Oils, Parts IX and X, by J. L. Simonsen	0 4 6
* „	Part	IX.—Note on the Work of Extraction of Broad Gauge Sleepers from Nepal, by J. V. Collier	1 11 0
*Vol.	X, Part	I.—The Constituents of some Indian Essential Oils, Part XI.—The Essential Oil from the leaves of *Cupressus torulosa*, Don., by J. L. Simonsen	0 3 0
* „	Part	II.—Oils and Fats from the Seeds of Indian Forest Plants, Part VI.—The Oil from the Seeds of *Aleurites montana* Wils., by R. N. Parker, M. Gopal Rau, W. A. Robertson and J. L. Simonsen, and Part VII.—The Oil from the Seeds of *Salvia plebeia*, R. Br., by M. Gopal Rau and J. L. Simonsen	0 9 0
* „	Part	III.—A Sal Yield Table for the United Provinces, by E. A. Smythies and S. H. Howard	1 5 0
* „	Part	IV.—The Constituents of some Indian Essential Oils, Part XII.—The Essential Oil from the Oleo-resin of *Pinus merkusii*, by J. L. Simonsen	0 2 0
* „	Part	V.—Analysis of the Tanning Properties of certain Burma *Lagerstroemias*, by E. Pasupati. Reported by J. A. Pilgrim	0 7 0
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FOREST RESEARCH IN INDIA, 1933-34.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

Work was continued in accordance with the sanctioned programme. The day to day enquiries continue to increase and it has been necessary to confine investigations to matters of real scientific interest in connection with investigations already in hand or to matters which give some promise of being of economic importance. The President has noticed a tendency to saddle the branches of the Institute with enquiries which would take months to complete and when completed would merely be of academic interest. In these days of retrenchment such investigations are to be discouraged.

Further improvements were made to the museums which manage to attract considerable numbers of visitors. During the year approximately 15,000 visitors passed through the museums and the largest recorded number was 1,708 in March. The Museums are now kept open during the hours of daylight. Endeavours have been made to maintain the closest co-operation with provinces. It is for provinces to send us their problems and to tell us how we can help.

In the Silvicultural Branch, useful progress can be reported in all sections. The close co-operation in field work with the Provincial Research Officers referred to last year has been continued and still further development in this direction is being called for ; it is to be discussed at a meeting to be held at Dehra Dun in October, 1934.

The results of the joint survey of management and regeneration problems for *Shorea robusta* were published in an illustrated Record and many of the recommendations have already been taken up in the provinces concerned. The all-India teak seed origin investigation in which eleven centres are taking part has been satisfactorily continued, although rather more difficulties were experienced than anticipated in obtaining the necessary fully stocked plots of different origins. The investigation

of methods of bamboo management (for *Dendrocalamus strictus* primarily) has also been prosecuted on a co-operative basis in five provinces ; the Branch accepted responsibility for the initial work of the experimental plots and this has been put through with the help of the provincial staffs who will undertake future maintenance. This work has brought to fulfilment one of the objects of the Branch hitherto unattained, *i.e.*, the use of the Experimental Assistant in the field in assisting the Provincial staffs on special problems, especially those paralleled in several provinces.

The study of increment and mortality statistics for uneven-aged crops has been the subject of discussion and correspondence with several provinces, and by taking over the routine sample plot work of the year from the United Provinces, their field party was freed to take up this subject on a programme mutually agreed to be the most promising.

The practicability of measuring standing sample trees with the use of a light sectional ladder and a swing seat was amply demonstrated, both in the hills and plains, for conifers and broad leaved trees. This meets a need already felt in connection with permanent sample plots and should result in a significant improvement in the precision of the measurements obtained. European experience has shown that this need will be intensified with the passage of time as good sample trees become more and more difficult to find, and the increased importance attached to varying thinning procedure particularly calls for repeated accurate measurements on standing trees in the experimentally thinned plots.

The publication of a " stand table " to supplement the existing yield tables for *Shorea robusta* may also be signalised as a useful piece of work. Hitherto, it has been possible to predict the number of trees per acre of fully stocked forest of known quality, and their *average* diameter. The new tables add the expected range of diameter around this average value with the proportion or number per acre in each diameter class.

Extensive field work on experimental silviculture is now not provided for at the Research Institute, but such investigations as can profitably be undertaken there, above all the study of experimental methods, are being continued. Among other items, are one or two experiments which are repeated on as nearly identical lines as possible each year to determine the influence of seasonal variations, and that dealing with pre-monsoon planting of teak stumps has given interesting results which were published with a general account of a series of experiments on winter planting. The progress of height growth during the season has been under study for a number of common species for several years, and the accumulated data were analysed with a view to publication shortly ; the differences from year to year are sometimes remarkable. Another small but interesting investigation was that on the effect of defoliation on the diameter and volume increment of young teak plantations.

A number of observations were recorded and experiments initiated on the question of root systems and root competition both as between trees of a crop and trees and grass or cover crops. One of these experiments involves a replicated series of plots of which very few yet exist in India. Several years must elapse however before definite results can be looked for.

In the Botany Branch Mr. Parkinson investigated further the species on the Bengal linear sample plots and continued his study of the Dipterocarpaceae. The usual additions and exchanges were made in the herbarium, and the Institute arboretum was still further enlarged. The investigation of Indian Peridermiums was brought a stage further by the publication of Dr. Bagchee's paper on *Peridermium himalayense*. A cultural study of wood rotting fungi is in hand and the investigation of the sissoo fungus continues.

In the Entomological Branch the outturn of publications issued or sent to press continues to increase,—thirty-nine items against twenty-five last year.

Field-work and transmission experiments with insects in research on the spike disease of sandal came to an end on termination of the special grant. A considerable quantity of evidence was accumulated that the disease is transmitted by insects and that a jassid bug, *Moonia albimaculata*, is a vector. This important achievement was not generally accepted as positively proved, and it is therefore a matter of regret that research had to be abandoned before unassailable scientific proofs could be presented.

The identification and ecological analysis of the sandal insect fauna continued and seven specialists furnished reports that added 297 species and 167 genera to the faunal list.

Measures were devised for the control of timber borers, marine borers and many groups of minor pests, which are acknowledged to have been successful.

Considerable progress was made in the investigation of the factors of natural control of teak defoliators as represented by prarasites and predators and the pests of trees and plants associated with teak.

A technique was evolved for tests of natural resistance, preservative efficiency and durability of timbers exposed to termite attack, and general measures for the control of termites in forests were published.

New investigations started include the borers of living bamboos, and the causes of the dying back of *champ* (*Michelia champaca*) in plantations.

About 58,000 insects were bred in the insectary and 287 new species were added to the Institute collection which now comprises 13,587 species.

In the Economic Branch a review of the year's working shows that a considerable amount of very useful research work was accomplished, and despite the heavy retrenchment to which the Branch was subjected two years ago, most Sections have settled down to the new conditions with remarkable tranquility and work has continued unabated, except for a reduction in the volume of the experiments done and a slowing down all round, which are unavoidable with reduced funds and reduced staff.

The Forest Economist toured round the sleeper depots of the Punjab in order to familiarise himself with the actual conditions of production and sale of sleepers, and the Inspector General of Forests toured with the Chief Engineer, North Western Railway, and the Timber Advisory Officer to the Railway Board, with a view to see for himself the service of the wooden sleeper in the line. A meeting of parties interested in the supply of coniferous sleepers was subsequently convened by the Inspector General of Forests to discuss problems connected with the supply of wooden sleepers which has somewhat clarified the situation and may lead to good. Partly as a result of the Inspector General of Forests' recommendation the treatment of deodar sleepers was sanctioned by the Railway Board which promises to add greatly to the diminishing serviceable life of this sleeper.

The work done by Dr. Kapur in connection with his new kiln-seasoning process is worthy of special mention. This new method of seasoning not only greatly reduces the consumption of steam and electricity, but shortens considerably the seasoning period, while at the same time producing seasoned wood of very high quality.

Another important feature of the year's working is the " fixation " of copper in conjunction with arsenic in wood for preservative purposes. The fixation of arsenic in wood has for many years been the aim of wood preservists and chemists throughout the world, but it was Mr. Kamesam of the Wood Preservation Section at Dehra Dun who ultimately achieved this. Mr. Kamesam has now gone one step further and has evolved a technique for fixing copper, in addition to, and in conjunction with, arsenic in wood for preservative purposes. If the new process, known as the Ascu process, fulfils all the claims made for it, the cost of wood preservation will be reduced enormously while the preservation of the wood should be improved.

The work done by Mr. Chowdhury in the Wood Technology Section and by Mr. Bhargava in the Paper Pulp Section is also worthy of notice, and it can be said of the Economic Branch in general that it has maintained its efficiency throughout the year and has kept up the high standard of work expected of it.

The Institute took part this year in the All-India Industrial Exhibition which was held in February-March, 1934. An Upper Grade Assis-

tant was in charge of the arrangements. He went with the exhibits to Delhi and stayed there for a week to answer enquiries. The average daily attendance at the stall was 909, but the number of serious enquiries received was far below expectations. Nevertheless the Forest Research Institute stall served its purpose in bringing to the notice of the public the fact that they could always apply to the Forest Research Institute for information and advice on all forest matters, and this is proved by the greater number of enquiries received after the exhibition. In these days of competition the Forest Department must advertise its products and must keep them before the eyes of the public. Propaganda in any form is good, but propaganda at exhibitions is now-a-days recognised as one of the best way to bring facts to the notice of potential purchasers.

The work in the Chemical Branch was chiefly confined to the general study of the chemistry and commercial uses of minor forest products. The bark of *Actinodaphne hookeri*, known to be a specific for diabetes in Indian medicine, was found to contain an alkaloid named ' actinodaphnine '. Its chemical constitution has now been determined and it has been found to belong to the aporphine group of alkaloids. It is of interest to find that the probable active principle of the tap root of *Bombax malabaricum*, known as " musli " in the Indian system of medicine and reputed to possess excellent tonic properties, is a cephaline like phosphatide, which rarely occurs in vegetable tubers. Rotenone, the active principle of *Derris elliptica* and *Caracca verginiana* roots, has become very popular as a valuable insecticide all the world over. Its demand in India is likely to increase in the near future hence the occurrence of *Derris elliptica* roots, containing 0·8 per cent. of rotenone, in Dibrugarh, Assam, may be considered as an important find, since it opens up the possibility of its cultivation in that locality, thereby ensuring a regular supply of roots of high rotenone content. Recently a new detergent consisting of sodium lauryl sulphate, has been put in the market under the commercial name of " Gardinol W. A." or " Orvus " and its demand is on the increase. The raw material for this preparation is trilaurin. A search for the sources of this raw material revealed that it occurs to the extent of 96 per cent. in the fat from the seeds of *Actinodaphne hookeri*, and 70 per cent. in the fat of *Litsæa zeylanica* seeds, and to a lesser degree in the fat from the seeds of *Cinnamomum camphora*. Oak acorns are at present a waste product of the forest but in America the acorns are considered to be a good feeding material both for poultry and cattle. The food value of Indian acorns has been found to be good. The oil content is low but it is a thin yellow oil of good quality consisting mainly of oleic and lignoceric glycerides. Under the President's direction a co-operative study of the semi-commercial cultivation of certain minor forest products chiefly medicinal plants has been started.

Mr. C. G. Trevor took over the post of Inspector General of Forests and President, Forest Research Institute and College, from Mr. A. D. Blascheck who proceeded on leave preparatory to retirement. Mr. Trevor wishes to thank the staff of the Institute for their loyal co-operation in the advancement of forest research and to record his appreciation of the work done by all branches in spite of the great reduction in their compliment due to retrenchment. Details of the work done in the several branches, list of publications, and statements of staff and expenditure are given in the chapters and appendices that follow.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Two notes on experimental work carried out at the Institute were published in the *Indian Forester, viz.*—

The effect of thinning out multiple shoots on young root stocks, *Indian Forester*, Volume LX, No. 1, January 1934.

Seeding of *Anogeissus latifolia* (Experiment 44), *Indian Forester*, Volume LX, No. 2, February 1934.

Another on teak defoliation was written up for publication during the year. An account of the experiments made on Winter planting was submitted for publication as an *Indian Forest Record.*

(ii) Natural regeneration.

The study of annual seed production and fertility of individual trees of *Anogeissus latifolia* was continued for the sixth year. The tests have not borne out the suggestion that a drought year is followed by a good seed year for this species in North India.

Seed crops from individual trees of *Shorea robusta, Pinus longifolia* and *Terminalia tomentosa* were again recorded. 1933 was a fairly good seed year for the former two species but *Terminalia tomentosa* produced no seed—these records must be continued several more years before analysis can be profitable.

(iii) Investigation on seeds.

(*a*) *Seed weighments and germination tests.*—During the year 112 weighments were made including 22 species for which no previous records were available.

(*b*) *Effect of size of seed on germination and growth of seedlings.*—The experiment was again repeated with teak in 1933, confirming the previous conclusion that the greater the size, the better the results.

(*c*) *Seed storage.*—Five species were added to the list under investigation, *viz., Terminalia arjuna, Dalbergia latifolia, Chickrassia tabularis, Terminalia chebula* and *Acacia modesta.*

For *Acacia catechu* and *Bombax malabaricum* stored in sacks, initial germinative capacity of 67 and 52 fell to 1 and 0·7 after one year, while stored in sealed tins, the figures were 25 and 36 respectively. *Cinnamomum camphora* with initial germinative capacity of 41 again gave 41

after storing for one year in sacks, while stored in a sealed tin, the capacity fell to 18, a rather unusual finding needing confirmation. After one year's storage, *Schleichera trijuga* and *Melia azedarach* shewed the same germinative capacity in sealed tins and sacks as their respective initial values, *i.e.*, 13 and 65 respectively.

(iv) Investigations on seedlings.

The morphological seedling studies as reproduced in Troup's *Silviculture of Indian Trees*, were completed for 8 species, *viz.*, *Acacia sundra*, *Buxus sempervirens*, *Diospyros ebenum*, *Saccopetalum tomentosum*, *Litsaea polyantha*, *Machilus gamblei*, *Sterculia foetida*, and *Stereospermum chelonoides*.

14 others were partly done, *viz.*, *Alstonia scholaris*, *Betula cylindrostachys*, *Boehmeria rugulosa*, *Bursera serrata*, *Cullenia excelsa*, *Dillenia pentagyna*, *Eugenia gardneri*, *Lagerstroemia parviflora*, *Nauclea excelsa*, *Pterocarpus macrocarpus*, *Sapium baccatum*, *Tecoma undulata*, *Turpinia pomifera*, and *Tsuga brunoniana*.

The experiment on the effect of burning back *sal* line sowings was continued another year, making the fourth and third year for the two replications. Comparing the results after three successive burnings, it is found that in both experiments the burnt sets have dropped about 10 per cent. behind the unburnt controls in average height, though after two burnings only they were equal or even somewhat superior. Cutting back would appear to confer a definite but slight benefit as regards height. The vitality of the 3 and 5-year old seedlings used in this experiment is very great and the three burnings have only resulted in 12 per cent. mortality as compared with 2 per cent. in the controls, 12 per cent. being quite unimportant in natural regeneration or line sowings. The fourth burning has proved as expected definitely detrimental, the stem height having now approached the limiting height attainable in one season's growth, *i.e.*, 5 to 6 feet. The controls take over a very significant lead, whilst the burnt plots only regain their original height cutting back again appearing slightly advantageous.

(v) Investigations on trees and crops.

(*a*) *Seasonal course of height growth.*—The necessary compilation work and detailed analysis have been done with a view to publishing the results for important species which have been under study for several years. Detailed correlation with climatic data does not yet appear possible.

The year under report has been conspicuous by the extremely poor growth for all species under study, the most probable cause being the exceptionally cool weather.

(*b*) *Phenological data.*—Observations were continued on fourteen species. Preliminary compilation work has been done, but detailed analysis remains pending.

(*c*) *Inheritance of individual characters.*—Seed of figured *Terminalia tomentosa* was received from South India and raised in pots for planting out in the rains of 1934.

(*d*) *Inheritance of climatic race characters.*—Work was completed with the All-India teak seed origin investigation. All the 11 origins have been planted in ¼ acre plots in the Experimental Garden.

With *Acacia catechu*, the Burma and local origin plots now begin to differ clearly in colour of foliage—the Burma being light yellowish green and the local dark green—and in bark, the local origin being still smooth at 3″ d. b. h. whilst Burma is already fissured at 2″ d. b. h.

(*e*) *Inheritance of physiological race characters.*—Small plantations of *Butea* and *Schleichera* forms reported to behave differently under lac culture are being kept under observation.

(*f*) *Soil Quality Class indicators.*—The quadrats in plantations of different species in the Demonstration Area were continued and the mapping methods improved. Invasion of *Imperata arundinacea* and *Ageratum conyzoides* is the striking feature of the year.

(*g*) *Congestion in bamboo clumps.*—An unexpected insect attack affecting almost all culms of 1933 prevented initiation of the intended experiments. The work is expected to be taken in hand in the rains of 1934. The experiments laid out in the United Provinces, Punjab, Bihar and Orissa, and the Central Provinces primarily for optimum bamboo management are expected to throw light on this problem also.

(*h*) *Root competition.*—A small scale investigation in replicated plots was initiated in *sal* and *chir* to study the effect of root competition of the suppressed and dominated stems on the dominant trees in a crop.

(*i*) *Thinning in young plantations.*—Two sets of plots were laid out in a 1925 *chir* plantation, one to determine optimum thinning intensity, and the other the best age at first thinning ; this work is expected to be more valuable from the point of view of determining the best experimental method, than from the immediate results, as the pine is not growing under conditions natural to it.

(vi) Artificial Regeneration.

The weather conditions affecting results were exceptional in that good rainfall was experienced in the 1932-33 winter and the 1933 hot weather, and the 1933 monsoon was also good. The results are shown in good survival but exceptionally slow growth, the low temperature and lack of sunshine throughout the growing period being perhaps the more immediate cause of the latter.

The 1933 monsoon broke on June 18th and was strong and well distributed till late in September.

The 1933-34 cold weather was also marked by normal rainfall but severe frost.

(*a*) *Line sowings.*—Various species were tried but the results were very poor probably owing to excessive and continuous rain. *Lannea grandis*, *Eugenia operculata* and *Terminalia chebula* sown in 1932 continue to develop satisfactorily.

(*b*) *Rains entire transplanting in the open.*—The following species were tried in 1933, the survival percentage at the end of the year being given in brackets. *Machilus gamblei* (83), *Garuga pinnata* (90), *Cassia siamea* (61), *Pterocarpus marsupium* (87), *Soymida febrifuga* (95) and *Lannea grandis* (98); until the plants have got over a dry season no practical conclusions can be drawn.

The following results were obtained at the end of second growing season with species tried in 1932, the figures giving survival per cent. at the end of the first and second seasons respectively.

Chloroxylon swietenia (84—0 per cent.), *Lannea grandis* (90—71 per cent.), *Carallia integerrima* (83—0 per cent.), *Eugenia operculata* (98——74 per cent.), *Schleichera trijuga* (5—0 per cent.), *Pterospermum acerifolium* (91—24 per cent.), *Stereospermum suaveolens* (86—70 per cent.), *Mallotus philippinensis* (78—28 per cent.), *Erythrina suberosa* (73—49 per cent.).

The failure of *Chloroxylon swietenia* and *Carallia integerrima* is ascribable to frost.

(*c*) *Rains entire transplanting in cleared lines.*—The following species were put out in 1933, the survival per cent. at the end of the year being given in brackets.

Schleichera trijuga (76 per cent.), *Cassia siamea* (39 per cent.), *Machilus gamblei* (98 per cent.)

For the species tried in 1932, the following figures shew the fall in survival per cent. during the second growing season. *Lannea grandis* (59 to 47 per cent.), *Carallia integerrima* (76 to 40 per cent.), *Eugenia operculata* (96 to 94 per cent.), *Schleichera trijuga* (35 to 25 per cent.), *Pterospermum acerifolium* (99 to 75 per cent.), *Erythrina suberosa* (29 to 10 per cent.), *Mallotus philippinensis* (62·5 to 60 per cent.).

(*d*) *Winter transplanting in the open.*—In December 1932 six species were put out and the survivals in December 1933 were found to be :—

Chloroxylon swietenia (5 per cent.), *Lannea grandis* (47 per cent.), *Soymida febrifuga* (26 per cent.), *Mallotus philippinensis* (0 per cent.), *Litsaea polyantha* (0 per cent.), and *Eugenia jambolana* (0 per cent.).

The high mortality is due to frost immediately after planting in December 1932, and it will be noted that only the deciduous species survived.

Three species were added in January 1934, *viz.*, *Pterospermum acerifolium*, *Terminalia myriocarpa* and *Terminalia arjuna*.

(*e*) *Winter stump planting in the open.*—In December 1932 six species were put out, and the survivals in December 1933 were recorded as :—*Acacia arabica* (0 per cent.), *Anthocephalus cadamba* (0 per cent.), *Garuga pinnata* (0 per cent.), *Erythrina suberosa* (84 per cent.), *Bauhinia retusa* (74 per cent.), and *Bauhinia variegata* (64 per cent.).

The stumps of the first three species were killed outright by frost immediately after planting in December 1932, the failure of *Garuga* being rather unexpected.

The following species are added during December 1933 :—*Cedrela toona*, *Celtis tetranda*, *Stereospermum suaveolens*, *Eugenia operculata*, and *Ougeinia dalbergioides*.

(*f*) *Rains stump planting in the open.*—The following ten species were put out in July 1933, the survival per cent. at the end of the year being given in brackets.

Grewia elastica (97 per cent.), *Olea glandulifera* (57 per cent.), *Terminalia chebula* (97 per cent.), *Xylia xylocarpa* (66 per cent.), *Eugenia operculata* (100 per cent.), *Ougeinia dalbergioides* (76 per cent.), *Shorea talura* (91 per cent.), *Erythrina suberosa* (93 per cent.), *Acacia arabica* (76 per cent.) and *Garuga pinnata* (98 per cent.).

Of the species put out in July 1932, *Albizzia lebbek*, *Cedrela toona* (both 100 per cent.) proved well suited for stump planting, *Bauhinia variegata* (83 per cent.), *Adina cordifolia* (77 per cent.), *Celtis tetranda* (84 per cent.), *Schleichera trijuga* (80 per cent.) were satisfactory, *Phoebe lanceolata* (64 per cent.), *Acacia catechu* (59 per cent.) fairly satisfactory, *Aleurites fordii* (42 per cent.), *Pterospermum acerifolium* (39 per cent.) poor, *Bauhinia retusa* (36 per cent.) and *Pistacia integerrima* (2 per cent.) unsuited. The figure in brackets is the survival per cent. at the end of the second growing season. The results are in keeping with general experience as reported in *Indian Forest Records*, Vol. XVI, Part VI.

(*g*) *Rains stump planting in cleared lines.*—*Amoora wallichii* and *Ougeinia dalbergioides* were put out in July 1933, survivals in December 1933 being 28 per cent. and 17 per cent. respectively.

Of the 1932 trials, the following survival percentages were recorded at the beginning and end of the second year : *Cedrela toona* (98—98 per cent.), *Albizzia lebbek* (96—87 per cent.), *Bauhinia variegata* (96—95 per cent.), *Aleurites fordii* (97—41 per cent.), *Pterospermum acerifolium*

(86—80 per cent.), *Phoebe lanceolata* (100—98 per cent.), *Schleichera trijuga* (96—92 per cent.), showing good results for all species except *Aleurites*.

(*h*) *Storage of stumps before planting.*—250 teak stumps made on 5th July 1933 were planted in comparable lots of 50 stumps after an exposure of up to 21 days to sun, rain and wind, in a heap on a cement floor; it must be remembered that there was more or less rain on 17 of the 21 days. At the end of the growing season the survival per cent. was 100, 100, 100, 86, and 76, and corresponding average height 7·9″, 7·7″, 7·0″, 6·5″ and 4·9″, for stumps exposed for 0, 5, 9, 15, and 21 days respectively, confirming earlier conclusions as to the exceptional vitality of teak stumps.

(*i*) *Early planting of stumps without irrigation.*—Teak stumps were planted fortnightly from 6th February to 20th June 1933. There were a few casualties on the earlier dates, but survival is virtually 100 per cent. throughout. This year, however, although every earlier set had a better average height at the end of the season than the June control, the differences are not great, being 4″ at the most, but expressed as a percentage (41 per cent.), they are appreciable and some are mathematically significant.

This experiment has been carried out annually since 1930 and the tentative conclusion drawn that early planting depends for its success less on past and current rainfall which is known, than on an early break in the monsoon which cannot so far be predicted.

(*j*) *Comparison of nursery stock and natural seedlings.*—In 1932 *Eugenia jambolana* jungle transplants were compared with two sets of nursery transplants, one being dug up from the nursery bed at the same time as the jungle plants and the other immediately before planting. At the end of the first growing season no significant difference was found between the three sets either in height growth or survival per cent., but it is probably significant that at the end of the second growing season the survival per cent. for the two nursery lots was reduced from 90 per cent. to 75 per cent. while for the forest lot it fell from 90 per cent. to 52 per cent., there being again no significant difference in height.

(*k*) *Comparison of nursery and forest stumps.*—*Eugenia jambolana* was tried in 1933. At the end of the growing season for both the lots, survival per cent. was found to be 100 with no significant difference in development.

(*l*) *Comparison of sowings, transplants, and stumps.*—It is difficult in this investigation to ensure comparability but the following is the record of observations at the end of second growing season for the four species tested in 1932.

Gmelina arborea.—Survival similar throughout but sowings with much lower height than entire transplants and stumps, the two latter being equal.

Tectona grandis.—Entire transplants were mostly killed outright by frost, stumps all escaping and shewing twice the average height growth.

Acacia catechu.—Entire transplants and sowings with equally high survival and height, stumps shewing only half the survival per cent. but a 50 per cent. better height.

Bauhinia variegata.—Survivals very high by all three methods, but average height dropping from sowings to stumps to entire transplants.

(*m*) *Araucaria cunninghamii plantation.*—The small plantation, though a good deal damaged by hail at the beginning of the year, is doing well, having reached an average height of about 3'-6" with no casualties.

(vii) Nursery work.

The severe hail storm on the 19th March 1933 destroyed most of the seed crop on the trees particularly in the Dun Valley, and hence the seed of many species was either unobtainable or defective.

Stock was raised for various species for use in the Experimental Garden and some experiments were carried out, *i.e.* :—

(*a*) *Manuring of nursery beds.*—The results obtained up to 1932 inclusive were published by Mr. Deogan (*Indian Forester*, 1933, pages 292-301). The relative value of farmyard, artificial farmyard and green manures were again tested with teak in 1933, the results being in general agreement with the earlier work. *Crotalaria juncea* was used as green manure but the growth was only slightly superior to the unmanured control. The plots treated with artificial farmyard manure were unfortunately defoliated and the heights attained probably do not reflect the full value of the treatment.

(*b*) *The effect of nursery bed shades on soil temperatures during cold weather.*—This investigation was undertaken to ascertain whether the losses experienced from frost were due more to low soil temperatures than to air temperatures. Beds shaded during the night only were compared with beds shaded day and night, and unshaded beds, temperatures being read soon after dawn and at 2 P.M. daily at depths of 3" and 12". The results bring out very clearly the value of night shading. At 3", the average early morning temperatures for December-February were 47°F. and 52°F. for the night-shaded and unshaded beds and this effect is partly carried over to the afternoon when the unshaded bed

remains 2° colder. At 12″ the night-shaded beds remain some 4° warmer day and night. On the other hand, the bed shaded day and night shewed the same minimum as the completely unshaded bed, the effect of lower day temperatures under shade not appearing to be carried over to the night, which was unexpected.

(viii) MISCELLANEOUS.

(*a*) *Effect of defoliation on diameter increment of teak.*—This investigation was taken up in consultation with the Entomologist to obtain statistical data under controlled conditions. Comparable sets of trees were defoliated by hand 2 or 3 times during the 1932 season and again in 1933, and compared with the untreated control. An epidemic attack by the leaf skeletoniser necessitated spraying the controls to minimise the attack on them. The defoliated trees produced a partial new flush of leaves late in 1933 and have unfortunately mostly been killed by frost. The results of this work are being published.

(*b*) *Methods of working bamboos for maximum sustained yield in quantity and value.*—The experimental plots laid out last year in the Punjab (Hoshiarpur division) and in the United Provinces (Lansdowne division) were reinspected and the varying treatments decided on actually applied during the 1933-34 cold weather ; both these sets which had been laid out by the Experimental Assistant, were visited by the Silviculturist with the local Divisional Forest Officer, and passed for handing over to the province for maintenance. The Experimental Assistant, Mr. Deogun, had also laid out similar sets of plots in collaboration with the Provincial Research Officers in Bihar and Orissa, the Central Provinces and Madras, thereby completing the initial work under this project. If maintenance is now adequately provided for, valuable data should be available in a few years' time, and this is considered one of the most important pieces of work accomplished in the season under report.

(*c*) *The All-India teak seed origin investigation.*—The collaborating Provinces and States all report progress with this investigation though it has proved much more difficult than could have been anticipated to get the requisite plots fully and evenly stocked. The Silviculturist was able to visit the plots in all the five S. India centres and discuss their further treatment with those in immediate charge. The differences in behaviour between the several origins under trial are even more marked than expected and the differences in appearance, particularly as between the Burma origins and the rest, are very obvious. Perhaps the most outstanding feature so far is the excellent results with Travancore seed which germinates very quickly and profusely, and shews excellent early development in most centres which have included it in their series.

(ix) Reclamation and afforestation.

The year under report has been a fateful one for the teak in the Demonstration Area as a number of calamities befell this species. The new flush of leaves had hardly appeared after recovery from frost in 1932-33 cold weather when on the 19th of March, a severe hail storm destroyed the tender shoots and in a good many stems forking resulted. The year was an exceptionally cool one—no month from November 1932 till October 1933 being rainless—with the result that the growth was extremely slow throughout. In the third week of September 1933 a sudden and severe attack of *Hapalia machaeralis* completely skeletonised the leaves throughout the plantation. About 40 per cent. of the plants so attacked came, late as it was, into new leaf, but the leaves were unable to grow more than one quarter their full size and the severe frost of 1933-34 winter killed the stems back to ground level, and has actually killed a large proportion outright, so that attempts to grow this species as a pure crop in this locality will be dropped.

(*a*) *Sal Working Circle.*—A total area of 3 acres was sown with Hoshiarpur, Haldwani and local origins. Frost damage in *sal* too was exceptionally severe.

(*b*) *Pinus longifolia.*—Casualties were replaced over 6 acres with Nainital, Hazara, Rawalpindi, Lansdowne, Chakrata and local origins. The year's growth was generally very poor.

(*c*) *Rosewood Working Circle.*—The 1932-33 and 1933-34 frost has killed back a good many plants and is apparently one cause of a witches' broom formation in the crowns. The future of this species also seems doubtful.

II.—STATISTICAL WORK.

(i) Yield Tables.

The multiple yield tables for *Cedrus deodara* prepared last year giving crop values for different grades of thinning were published as an *Indian Forest Record.* They make a formidable array and helpful criticism is hoped for to permit of subsequent improvements.

The provisional yield table for *Quercus incana* gave a great deal of work as various lines of attack that had appeared promising during the preliminary investigations, proved to be much less satisfactory on further examination and test. A table has been compiled and is in the Press, but it leaves much room for improvement, and it is to be hoped that a fairly early revision will become possible.

The stem distribution data required to supplement the published yield tables for *Shorea robusta* were worked up and published as an *Indian Forest Record*. This makes it possible to determine the average proportions or numbers of trees of different diameter classes which go to form a crop of given crop diameter, information which is frequently needed in divisional and working plan practice.

All-India teak yield tables have still to be compiled though the Nilambur tables continue to provide a useful standard. Tables have recently been published in Java in metric units and a form differing from Indian standards. With the author's permission, these are being converted to English units and the standard Indian form, for comparison with Indian data.

The trials with a sectional ladder for the measurement of standing sample trees were continued in the Kumaon hills mainly on *Pinus longifolia*, in co-operation with the United Provinces sample plot field party for whom the large sample trees were measured which were not available for fellings. The results were considered quite satisfactory, and an account was published as *Forest Bulletin* No. 82.

The routine remeasurement work due in the Dehra Dun and Saharanpur divisions was later undertaken by a Research Institute field party which demonstrated the practicability of the method in standard practice. The possibility of the derivation of the required measurements from photographs taken for the purpose is still under examination.

As usual, work on standard sample plot files occupied much of the time of the computing staff, but owing to the amount of special work in hand, the number disposed of, 180, was rather less than usual and was actually 142 less than the number received from the provinces.

The total number of sample plots now maintained is 1,475 of which 322 are in Burma and 1,153 in the rest of India. Additions during the year, totalling 50 (nett), are mostly among the species for which yield tables have not yet been published, many of them being in young plantations just big enough for laying out plots—thus several for *Terminalia myriocarpa* and *T. tomentosa*, and 4 for *Michelia champaca*. No new plots were laid out by the Forest Research Institute during the year.

(ii) Volume Tables.

No field parties were sent out during the year for the collection of volume table data. There is a lot of work still to be done in this direction, but it can be effectively done by the divisional or provincial research staffs, provided care is taken to ensure work on the right lines. Assistance was given to provinces in compilation work but no new tables were published.

(iii) MISCELLANEOUS WORK.

Field data collected in the Central Provinces for determining the best rotation for *Cleistanthus collinus* in coppice coupes and the effect of cleanings and thinnings on its growth were analysed, but unfortunately it had proved impossible to adhere to the original project and the deviations from it defeated its primary aim of rendering statistical analysis possible.

In connection with the initiation of special research work on some factors connected with resin production in *Pinus longifolia* by the United Provinces, which work was inspected with the Provincial Silviculturist, material was collected for an examination of the distribution of resin ducts near the top of channels under tapping and a large number of counts made under the microscope. The data collected now await analysis.

A large amount of figuring and curve drawing was involved in the compilation and analysis of 6 years' data for the seasonal progress of height growth of several species of trees.

III.—MISCELLANEOUS.

(i) PHOTOGRAPHIC SECTION.

The routine work dealt with compares with previous years as follows :—

	Negatives made.	Prints made.	Lantern slides made.
1931-32	1,071	2,661	60
1932-33	677	2,276	44
1933-34	1,095	2,271	400

It is satisfactory that the outturn of work has been more than maintained despite retrenchment in the Section.

Of the new negatives, 243 were photographs taken by the Silviculturist on tours in the United Provinces, South Bengal and South India, and 28 by the Experimental Assistant in the course of his bamboo field work, 232 concern the Timber Testing Section, and a further 592 were photographs taken for the other branches and sections of the Institute.

The negative collection of the United Provinces' Silviculturist has been lodged with the Institute, and Bihar and Orissa are likely to send in theirs also. The use of glass negatives has been largely discontinued in favour of cut films which, apart from technical points, possess special advantages in use, transport and storage.

The 2271 prints made were mainly enlargements from negatives of various sizes to the standard full plate size of the Institute photographic collections. The silvicultural collections have been increased by 310 to 3811 in the specific series and by 314 to 2976 in the general series. 235 prints were received directly or indirectly from provinces, a similar number to last year's. A selection of the more generally interesting additions were circulated to provinces as usual and copies supplied as required. 98 photographs were used as illustrations in various publications, and a number were used for an Industrial Exhibition at Delhi.

It will be noted that a large addition has been made to the lantern slide collection. The conversion of the print collections to a standard basis was only completed last year rendering it possible to take up the work of organising the lantern slide collection on similar improved lines. It is expected to complete this during the next year, after which maintenance and steady improvement of the collection should be a routine matter.

Considerably more stereoscopic photographs have been taken during the year and others are expected from provinces, but development in this direction is still needed.

The section has acquired a Cine-projector during the year, which should mark the beginning of expansion in a new field, though as yet we have no cinematographic camera.

(ii) Records.

Referencing work has more or less kept up with new foreign literature coming in during the year, but has been rendered more difficult by the lack of an assistant able to read German or French. The Silviculturist unaided cannot possibly find time to read or translate all articles in foreign languages which call for critical scrutiny, with the result that many have had to be referenced by title only.

Good progress has been made in marking for ledgering the very large accumulation of working plans, but the cutting up and filing has become a big task which will take some time. Indian forestry publications were abstracted for " Biological Abstracts " as usual.

The number of new specific files opened during the year was 7, bringing the total up to 1180, the corresponding figures for the general files being 10 and 431. The survey of available information on the regeneration

and management of *Shorea robusta* was completed and published, but it has not yet been possible to take up another species in the same way. The question of compiling a general manual of Indian Silviculture, which would be largely based on the general ledger files, is under consideration.

New volumes added to the Silvicultural library during the year totalled 40 (15 working plans), bringing the total to 633 books and 341 bound periodicals. The usual list of important additions was circulated with brief abstracts to Provincial Silviculturists.

(iii) Working Plans.

Notes have been written on West Almora, Tarai and Bhabar, Banda, Jorhat, Sadiya, Hamirpur, and S. Raipur (*sal*) draft working plans during the year, from four provinces, and the suggestions made have very generally been adopted. Calculation of yield continues to receive much attention, especially in the United Provinces where methods are being developed to ensure the maintenance of the outturn in timber sized trees, a matter which experience has shewn tended to receive insufficient attention under past methods relying on a general volume or area control only.

(iv) Museum.

A large scale model, 12′ × 6′, of forest management under the strip regeneration system was completed, and considerable progress made with one reproducing as nearly as possible to scale an actual deodar sample plot. The next to be constructed will be one to demonstrate the influence of forest cover on erosion.

(v) Staff and Touring.

The Silviculturist made a tour in the Kumaon circle of the United Provinces in May-June 1933 taking a sample plot field partly with which a thorough and satisfactory trial was made of measuring standing sample trees of *Pinus longifolia*. During this tour, a visit was also made with Provincial Silviculturist to the resin tapping experiments which mark an important advance in research methods as applied to such economic forest problems.

In November-December 1933, a six weeks' tour was made with the Conservator of Forests and the Bengal Silviculturist in the Chittagong forests where important progress has been made in the problem of the artificial regeneration of tropical evergreen species, and where experiments on natural regeneration and bamboo management are also being carried out. The experimental plots concerned were inspected and their further maintenance considered in light of results to date. A note was

prepared describing the chief points of this work and circulated to other interested provinces.

In January-March 1934, a prolonged tour was made in S. India, mostly with the Madras Silviculturist, and silvicultural work inspected in Madras, Coorg, Mysore, Travancore and Cochin. The progress made in experimental methods in Madras since the last visit in 1927 was most noticeable. The problems connected with the tropical evergreen forests were given special attention, and the opportunity utilised for studying the different types of forest occurring in South India and the irinterrelationships.

The Experimental Assistant made a prolonged tour to complete the series of experimental plots for the investigation of the best felling cycle and cutting methods for the bamboo *Dendrocalamus strictus*. The plots in the Punjab and United Provinces were revisited and a first felling made—these were later separately inspected and passed by the Silviculturist. Series of plots were also added in Orissa, the Central Provinces, and (after the end of the year) Madras.

The Statistical Assistant took out a sample plot field party which remeasured all the plots of Dehra Dun and Saharanpur divisions. This work would of course normally be done by the United Provinces' Silviculturist, but the arrangement was made to free his party for special work on the problem of the growth statistics of uneven aged forest in areas less easily accessible from Dehra Dun, a problem which is being specially taken up.

Mr. Mahendru reverted to the Punjab at the beginning of the year, and was succeeded as Statistical Assistant by Mr. Kakazai from the United Provinces; Mr Mahendru is now Silviculturist in his province. Mr. Deogun was Experimental Assistant throughout the year. There were no changes in the rest of the staff.

(vi) Forest grazing experiments.

Data collected in several divisions in the Central Provinces for the effect of various schemes of rotational closure with different grazing intensities and topographical features were examined at the request of the province and suggestions made for developing the project in the light of the results obtained and with modern research technique.

CHAPTER III.—BOTANY BRANCH.

1. *Systematic Botany.*—The systematic study of plants of the family *Dipterocarpaceæ* was carried out as follows. Two South Indian *Hopeas*, *H. wightiana* Wall. and *H. glabra* Wight and Arn., hitherto confused, and the Burmese trees *Scaphula glabra* Parker and *Anisoptera oblonga* Dyer, have been figured and described and the manuscript completed for submission for publication. Further studies and observations on Indian trees of this family for the continuation of this work were made by the writer during a visit to the Herbarium at the Royal Botanic Garden at Calcutta.

A paper dealing with a Burmese bamboo of forest importance, *Dendrochloa distans* Park.,was published in the *Indian Forester* as well as a paper dealing with the Indian species of the genus *Xylocarpus*, trees of forest importance in Bengal and Burma, which have hitherto been confused both in botanical literature and in the field.

Dr. J. M. Cowan's paper on the genus *Wendlandia*, published in Notes of the Royal Botanic Gardens, Edinburgh, was summarised for the *Indian Forester* as this genus is of some forest importance and interest, and in this connection the herbarium material of the genus at the Dehra Dun herbarium was examined and re-arranged.

The collection and examination of a large amount of material of Indian *Terminalias* of the section *Pentaptera*, all trees of forest importance, has received the attention of the Forest Botanist and much of this material has been examined and sorted out and selected specimens sent to the Royal Botanic Gardens, Kew, and the Botanic Garden and Museum at Berlin for comparison with collections at the herbaria of those institutions.

2. *The Herbarium.*—3,271 sheets were added to the herbarium during the year from the collections of the Forest Botanist and his staff and of forest officers in India, and from specimens received by donation or exchange from other herbaria as shown below. The donation of nearly 2,800 Malayan sheets, the collections of Dr. Kunstler, Dr. King and the Rev. Fr. Scortechini, by the Superintendent of the Royal Botanic Garden, Calcutta, is much appreciated and forms a most valuable addition to this herbarium. These collections are now in the process of being incorporated.

Royal Botanic Garden, Calcutta	2,793
Forest Botanist, Maymyo, Burma	404
Herbarium of the Arnold Arboretum	328
Temple University, Philadelphia	200
Natural History Museum, Stockholm	87
Botanic Garden, Singapore	39
TOTAL	3,851

About one thousand specimens were distributed to other herbaria as donations or in exchange as follows :—

Botanic Garden and Museum, Berlin	333
Maymyo herbarium	244
Royal Botanic Gardens, Edinburgh	183
New York Botanic Garden	131
Botanic Garden, Sydney, N. S. W.	60
Temple University, Philadelphia	50
TOTAL	1,001

290 specimens were received on loan from the herbaria at Calcutta, Maymyo and Shillong, and 274 were sent out on loan chiefly to the Economic Botanist, Cawnpore (*Brassica* spp.), and to the herbaria at Calcutta, Berlin and the British Museum.

116 specimens were sent out for identification or the confirmation of identifications chiefly to Kew.

The re-arrangement of the foreign (non-Indian) collections in the herbarium was started during the year and the work has already progressed well. These collections have hitherto been placed in "Foreign" genus covers but the comparatively large increase in their number, obtained chiefly by exchange during the last few years, has made it necessary to re-arrange them under seven broad geographical units for convenience of reference. The Indian collections continue to be grouped under the three headings North-west and Central India, Bengal, Assam and Burma, and South India, and the non-Indian collections are now grouped as follows :—Asia east of India, Asia north of India, Asia west of India, Europe, America, Africa and Australasia.

3. *The Library.*—In addition to the usual number of periodicals added annually—about 60 in number—35 new books were added to the library during the year.

4. *Identification of specimens.*—About 900 specimens were identified during the year of which a large number are the collections of the Forest Botanist and his staff. The remainder were sent in chiefly by Dr. R. M. Gorrie (North-West Himalayan species) and Mr. H. G. Champion, Silviculturist (Chittagong and South Indian collections) and smaller lots by Forest Officers in India and Burma. In addition to the above the greater portion of a collection of 200 specimens brought in by the Forest Botanist from Bengal and of a collection of about 200 specimens from Lahaul and Spiti, sent in by Mr. H. A. C. Gill, I.C.S., have also been examined but have not yet been incorporated in the herbarium.

Tours.—A tour of about four weeks duration was made by the Forest Botanist in Northern Bengal with the Conservator of Forests of that

province in connection with the identification of trees in the Linear Sample Plots, chiefly in the Buxa and Jalpaiguri divisions. During this visit about 200 herbarium specimens were obtained. A short visit was also made to the forests of the Sunderbans for the collection of herbarium material of mangroves. In continuation of this tour the Forest Botanist spent about a week at the Herbarium of the Royal Botanic Garden, Calcutta, for the purpose of the examination of specimens of Dipterocarpaceæ and the critical comparison of material from the Dehra Dun herbarium with types at the Calcutta herbarium.

Kirat Ram, Field Assistant, accompanied the Inspector General of Forests on his visit to the Andaman Islands last February and remained there for the purpose of collecting specimens till about the end of March. His collections, amounting in all to 250 specimens in triplicate, have been received and await examination.

5. *Supply of Seed.*—In addition to numerous small authentic samples of seeds supplied to various scientific departments for experimental purposes and to various institutions on an exchange basis, twenty five larger indents, aggregating some 2,500 pounds of seed, were complied with during the year. The seed mostly in demand were *Pinus longifolia* and *Pinus khasya* for South Africa, *Cupressus torulosa* for South Africa and Ceylon, and *Dalbergia sissoo, D. cultrata, D. oliveri, Adina cordifolia* and *Pterocarpus marsupium* for Java.

In connection with the supply of seed the want of a collection of authentic samples for purposes of comparison is felt and a start has already been made in the building up of such a collection.

6. *Arboretum and Fruticetum.*—In the arboretum 41 trees representing 8 genera and 5 families and in the fruticetum 40 plants representing 11 genera and 9 families were planted out. In addition to these some 300 plants were raised in the botanical experimental garden for planting at New Forest and in the grounds of the Indian Military Academy.

Seeds obtained from the following plants were tested for germination and, proving fertile, these were added to our seed exchange list : *Acacia saligna* Wendl., *Aristolochia macroura* Gomez, *Enterolobium timbouva* Mart., *Millettia tetraptera* Kurz., *Rhynchosia minima*, DC., *Rivea hypocrateriformis* Choisy, *Sophora griffithii* Stocks.

The following plants flowered for the first time at New Forest : *Natsiatum herpeticum* Ham., *Chloranthus officinalis* Bl., *Naravelia zeylanica* DC., *Cassia multijuga* Rich., *Cymbopogon osmastonii* Parker, *Plantago lanceolata* Linn., *Gomphostemma parviflorum* Wall., *Cestrum diurnum* L., *Laportea gigas* Wedd., *Thunbergia natalensis* Hook, *Galtonia princeps* Dcne., *Talinum paniculatum* Gærtn., *Solanum gilo* Raddi, *Solanum asymbrifolium* Lamk., *Halleria elliptica* L., *Petiveria alliacea* L., *Heteromorpha arborescens* Cham. & Schelecht.

Plantago lanceolata, one of the Psyllium-seed plants, flowered well during the last rainy season but owing, apparently, to late sowing and the excessive dampness at the time of flowering during the monsoon, would set no seed. At the time of writing, however, it is flowering again more profusely than ever and it appears likely that good seed will be obtained before the rains set in.

Paspalum dilatatum, a foodder grass from the Argentine, sown in 1932, is beginning to spread spontaneously in the experimental garden.

In the arboretum *Amoora wallichii*, *Afzelia quanzensis* and *Erythrina velutina* have been killed or badly damaged by frost, while more than one attempt to grow *Acacia koa* with success has failed, due apparently, to the want of proper bacterial root infection. On the other hand, several other introduced *Acacias* such as the South African green-barked *Acacia*, the Australian *A. confusa*, and the Indian species *A. suma*, A. *lenticularis* and *A. ferruginea* are doing well as also several other leguminous plants such as *Xylia dolabriformis* and *X. xylocarpa*, *Ceratonia siliqua* and *Derris robusta*.

A new botanical garden is being laid out in the grounds hitherto occupied by the Minor Forest Produce garden and the botanical experimental area, the former still being retained as part of the garden. A portion of this area has been allotted for experimental plots for the cultivation of plants of economic importance on a semi-commercial scale, while the remainder is being devoted to the planting of trees, shrubs and climbers of botanical interest or ornamental value.

7. *Miscellaneous.*—In the course of routine work advice and technical information was supplied to forest officers and other enquirers from various parts of India and Burma.

8. *Staff.*—The post of Forest Botanist was held throughout the year by Mr. C. E. Parkinson who was assisted by Mr. Mukat Behari Raizada, Lower Grade Assistant.

The Mycological work reported on below was carried out by Dr. K. D. Bagchee, Mycologist, Mr. A. Hafiz Khan, Upper Grade Assistant, and Mr. R. N. Chatterjee, Laboratory Assistant.

MYCOLOGY.

9. *Shisham root disease.*—The inoculations made on *shisham* (*Dalbergia sissoo*) trees with *Fusarium* sp. are showing successful results. Cultural studies of *Fusarium* sp. and of *Ganoderma lucidum* and *Polyporus gilvus* are being carried on.

The die-back disease of Gmelina arborea.—Cultural studies of the fungus isolated from dead leaves and twigs have been continued and the cultures have produced copious pycnial fruit-bodies which are comparable with those found on the infected leaves and twigs.

Inoculation experiments conducted on potted young plants in chambers, with controls, have successfully produced infection and show pycnial fruit bodies similar to those found on the naturally infected trees.

Peridermium himalayense.—Part 2 of the investigations on the infestation of this fungus on *Pinus longifolia* dealing with the distribution, morphology, pathology, biological relationship and control of the alternate stage *Cronartium himalayense* on *Swertia* has been published in the Indian Forest Records.

Peridermium indicum.—The morphological study of the fungus has been concluded.

Damping-off disease of seedlings of forest importance.—Some organisms known to cause damping-off have been isolated and are growing in culture and from observations made the percentage of damping off has been estimated for the following species :—*Soymida febrifuga, Terminalia tomentosa, Dalbergia latifolia, Dalbergia sissoo* and *Gmelina arborea.*

10. *Cultural studies of wood-rotting fungi.*—Cultural studies of six typical wood-rotting fungi common in the Indian forests and in timber yards have been undertaken. Inoculation experiments have been done on *Dalbergia sissoo* and *Dalbergia latifolia* grown under controlled conditions with two of these organisms to study their pathogenicity on living plants and also on blocks of wood of *Dalbergia sissoo* and *Adina cordifolia* to test, at the same time, the wood-rotting properties of these fungi. Two more will be taken up this year in this connection.

11. *Sal root disease including Polyporus shoreæ.*—A large number of specimens of diseased and dead sal trees from the United Provinces and Bihar and Orissa were examined. Some local tours were made in the Dehra Dun forest division to study the problem of sal mortality in the local forests and from observations it appears that the disease is correlated with drought conditions resulting from scanty rainfall during previous years. More evidence on this problem is being collected from the other divisions where sal has been dying during recent years and more material will be examined in this connection.

12. *Routine work.*—The collection and identification of hard fungi with the idea of building up our local collection for purposes of identification and reference is being continued ; some notable additions have recently been made of *Polyporaceæ* and *Thallophoraceæ* from Bengal. Our Kumaon collections of *Polyporaceæ* have mostly been identified and incorporated. Arrangements are being made with specialists in Europe and America for the identification of Himalayan rusts and the exchange of these with European types.

Many enquiries and specimens for examination have been received from various forest divisions among which are included some interesting

tree fungi such as a rot on *Cinnamomum cecidodaphne* from Jalpaiguri, Bengal, and on teak from Angul, Bihar and Orissa, die-back specimens of *Michelia champaca* from Kurseong, Bengal, witches-broom specimens of bamboo from Lansdowne, United Provinces, specimens of dry rot in the timbers of *Phœbe hainesiana* and *Amoora wallichii* from Lumding, Assam, etc. These have been examined more or less in detail but are treated as problems secondary in importance to the sanctioned programme of work and are carried on as far as time permits.

CHAPTER IV.—ENTOMOLOGY BRANCH.

Insects of Sal.

As a result of the remedial measures carried out in Haldwani division, United Provinces, where the timber of sal trees, that were dying-off in thousands, was being depreciated by the attack of secondary borers, the trouble has been checked. The 3,700 commercially useless trees felled as traps absorbed most of the borer attack and the damage to standing dying trees was very much reduced. The control operations are being continued and an additional measure involving auctioning at the end of the monsoon and extraction before the following March is being adopted without loss of revenue to the department.

The cause of the mortality of sal, which still continues, was further investigated and it was found that the extensive carbonisation of the bark resembling scorching by fire is caused by an ascomycetous fungus, *Hypoxylon annulatum*, a saprophyte of dead bark and rotted wood. In the roots of dying and dead sal a mottled discolouration was produced by a fungus, *Polyporus gilvus*, which may be directly parasitic.

Insects of Teak.

Phassus malabaricus.—The Phassus borer of teak is extremely polyphagous; records were made of twenty-seven alternate food-plants most of which are shrubs or saplings of underwood trees forming the soil-cover in plantations. An attack by the borer in *Eucalyptus robusta* plantations in Coorg was found to have spread from the very high infestation of the dense undergrowth in this locality. The life-cycle is annual, moths emerging in May-June. A Dexiid has been obtained as parasite of the mature larva.

Defoliators.—The young foliage of *Kigelia pinnata* is an alternate food of *Hyblaea puera;* the older leaves are not eaten. Survival of *puera* caterpillars on teak is three times as great as on *Kigelia.*

An epidemic of *Hapalia machaeralis* occurred in the Central Provinces and at Dehra Dun towards the end of the monsoon of 1933. This appears to have been caused by the abnormally high rainfall of May-June 1933, bringing teak into leaf earlier and enabling æstivating moths of *machaeralis* to breed.

Diacrisia obliqua confusa was reared on teak, *Clerodendron infortunatum* and *Vitex negundo.* A pupal period of four months, December to April was recorded in Dehra Dun.

A study of the ecological factors influencing the incidence of defoliation in the Nilambur teak plantations, Madras, was made in April-May

1933. No correlation could be found between the initial appearance of defoliation on the new flush and the present state of the teak stand or the composition of its underwood, taking the compartment as a unit. The spread of the moths during the flight of the first generation from localities where winter survival is high counter-balances the deficient population in localities where survival is low. Over a period of years, however, the frequency of light defoliation is high in the age-class 1-10 years but the incidence of serious defoliation is not high ; the frequency of general defoliation is highest in the age-classes 11 to 45 and the incidence of serious defoliation is also highest, being at its maximum in the 21-30 class ; in the 51 to over 70 age-classes the frequency is lower than in the younger crops, and the incidence of serious defoliation is lower than at any age except under five years.

It is believed that the gradual falling off in the intensity of defoliation from the age of 30 years which becomes still more marked from the age of 50 years is due to the invasion and establishment of a mixed underwood with its accompanying micro-fauna, *i.e.*, to the gradual increase in the variety and efficiency of natural control in the form of predators and parasites. The relatively low intensity of serious defoliation in the first 10 years, on the other hand, appears to be an effect of the food-supply of the defoliators, as the young teak matures its foliage more rapidly at the critical season.

The biological control of teak defoliators is therefore a matter of the early introduction of an underwood or undergrowth, but one composed of species that favour the establishment of natural enemies. Ecological surveys are now in progress to determine the defoliator fauna of the common plant associates of teak in plantations from this aspect. As is usual a large proportion of the species of defoliators, predators and parasites resulting from such a survey prove to be new.

Insects of Sandal.

Analyses of collections.—The greater part of the insect fauna of the sample plots has been completely analysed and the seasonal incidence and distribution worked out for the Anthicidae, Cercopidae, Coccinellidae, Elateridae Formicidae, Fulgoridae, Jassidae, Membracidae, Neuroptera and Pentatomidae. In this work over 46,000 specimens were identified.

Taxonomy.—Reports on the identification of the insects of sandal, *Santalum album*, have been prepared by specialists and sent to press, *viz.*, Anthicidae by R. Heberdy ; Melasidae and Elatridae by E. Fleutiaux ; Jassidae by H. S. Pruthi ; Coccinellidae by R. Korchefsky ; Formicidae by D. Mukerji ; Pentatomidae by N. C. Chatterjee ; Thysanoptera by T. V. Ramakrishna Ayyar. These papers add 297 species and 167 genera to the insect fauna of sandal.

Bionomics.—Work on the life-histories of several sandal insects was continued and one paper was published in *Indian Forest Records.*

Transmission Experiments.—The work on the experimental transmission of the spike disease of sandal by means of insects was continued at the Insectary, Indian Institute of Science, until the end of September 1933. The results of two hundred experiments with thirty-one species of Hemiptera appear to confirm the theory previously advanced that if spike is carried by insects it is very probable that the Jassid, *Moonia albimaculata*, is a vector. Highly suspicious symptoms were obtained in five well-defined cases as the result of infection with viruliferous individuals of this species. A careful study of the symptoms and biological considerations, and analyses of total nitrogen and starch contents leads to the conclusion that these plants are spiked though not virulently so. A cytological examination by Mr. M. J. Narasimhan, Mycologist to the Mysore Department of Agriculture, supports this contention, intracellular inclusions having been found by him in sections prepared by him.

Lantana aphids are also suspected as vectors of spike disease, one plant apparently being infected as a result of transmission experiments. Seventy-two cases in which species of beetles were used yielded negative results.

These data have been published in the *Indian Forest Records* and have also formed the subject of some notes in *Nature.* The deduction that spike has been experimentally transmitted by insects and that *Moonia albimaculata* is a proved vector has not been generally accepted, mainly because leaves from the *Moonia* and aphid affected plants, when grafted on to healthy plants in order to ascertain if the diseased conditions were transmissible by grafting, failed to take and gave negative end-results. In the meantime the special grant subsidising research on spike disease has expired and the investigation has been closed down. It is a matter for regret that the retrospective decision of the Government of Madras to cease research on this subject makes it impossible to present unassailable scientific proofs of this achievement.

Insects of Bamboos.

Borers of felled bamboo, *Dinoderus* spp. In bamboos felled at the right season of year practically no damage takes place in the forest. The damage develops in the storage depots, where infested stock is held for more than a year. An article on the protective measures to be taken for stored bamboos was published in the *Indian Forester.* It was also demonstrated that the specifications for lance staves of solid bamboo, and for tent and telephone poles with regard to borer holes were unnecessarily strict, and that a revision of the specifications should reduce

considerably the price at which contractors can supply material, and should reduce the rejections of materials in use and reissued.

Damage by borers to living bamboos *Dendrocalamus strictus* was investigated in Landsdowne division, U. P., and at Dehra Dun ; the species concerned are *Estigmena chinensis* (Chrysomelidae), *Cyrtotrachelus* sp., and *Myocalandra exarata* (Curculionidae).

The beetles of *Estigmena chinensis* appear at the beginning of the monsoon and lay eggs under the sheaths on growing culms. The larvae feed superficially on the internode and finally bore into the thickness of the wall excavating a longitudinal narrow tunnel a few inches long in which pupation occurs in September. The beetles form in about a fortnight and remain in the tunnel from the autumn until the rains of the following year. Damage by this species appears to be most frequent in solid bamboos of small dimensions and in the solid part of large hollow bamboos ; thin walled hollow bamboos are not usually attacked. Second year and older culms are not attacked.

Damage believed to be due to *Cyrtotrachelus* is characterised by a long tunnel starting at a shallow excavation beneath a culm sheath and passing internally through several internodes, grooving the inner side of the wall, perforating each node passed, and terminating in a hollowed out and killed terminal shoot. The dead top of the culm may surmount a length of anything from a foot to fifteen feet of living culm if the bud is not killed right back at the beginning of the monsoon.

No living insects were found in the spring in culms attacked during the previous rains.

Damage of this type is commonest in dense crops of bamboos and in those unworked for more than four years. It is not entirely similar to the work of *C. longipes* in *Melocanna bambusoides* or in *D. strictus* in the Central Provinces.

Myocalandra exarata lays eggs in the abandoned tunnels of *E. chinensis* in second year and older culms. The tunnels run in the internodal wall and in solid internodes but do not penetrate nodes. The damage is entirely secondary to the attacks of primary borers.

A secondary disease of bamboos was found in which a fungus and a bacterium are associated.

Control measures appear to coincide with the prescriptions for the exploitation of bamboos already laid down in working plans. In cases of very bad attack by *E. chinensis* the cutting of the culms of the current year only is advised.

Insects of Champ.

An insectary was established in Kalimpong division, Bengal, in October to study the dying-back of *champ* (*Michelia champaca*) in planta-

tions and the insects associated with it. The pentatomid bug, *Urostylis punctigera*, was found to occur in all the *champ* plantations of Buxa, Darjeeling, Jalpaiguri, Kalimpong and Kurseong divisions and on natural forest trees. It also breeds on *Michelia excelsa* in the Tista valley and on *M. montana* at Lataguri. It is apparently an endemic species in the Duars and foothills of north Bengal.

The life-cycle of *U. punctigera* takes about 30 days in September and 45 to 105 days in the period October to January. The adults are long lived—up to 5½ months—and pass the colder weather sheltering in the dry or curled *champ* leaves on the tree. There is no indication of a prolonged period of hibernation or prolonged break in the reproductive activity of the insect. Egg-laying recommences about the middle of March.

It is improbable that the drain of sap from the young flush of foliage and stems by a massed attack of bugs is sufficient to cause the dying back of the whole crown or of the bole nearly to ground-level.

A rot due to a *Fusarium* producing *Nectria* fructifications in the later stages has been found and it is possible that this fungus is a primary disease of *champ*. The connection between the fungus and the bug is to be discovered.

Observations on the life-histories of defoliators, leaf-rollers and leaf-curlers and leaf-miners and shoot-borers of *champ* are in progress.

Insects of Deodar.

The investigation of the causes of the dying-off of deodar seedlings and transplants in nurseries was continued by visits to Chakrata division, U. P. In the spring very young seedlings are cut back by cutworms which appear to be half grown caterpillars that have hibernated. The cutworm population is mainly supported by weeds among which *Rumex nepalensis* is important.

Further observations on transplants showed that most of the casualties are due to causes other than insect attack, bad planting and desiccation being important factors. Cockchafer grub damage was slight.

Insects of Hollock, Mulberry, Oaks and Shisham.

The borers of felled hollock (*Terminalia myriocarpa*) are being investigated by breeding from logs exposed for various periods in Sadiya division, Assam, and Kalimpong division, Bengal, as a preliminary to the isolation of those species primarily attacking the living trees.

An *Indarbela* is reported as injurious to young saplings of this species in Sibsagar division, Assam.

Life-history studies of a defoliator of mulberry (*Morus indica*), a pyralid, *Glyphodes pyloalis* were continued at Dehra Dun.

Malacosoma indica occurred sporadically on *Quercus dilatata* and *Q. incana* in the Muktesar laboratory forests and in Naini Tal division in 1933 but no field-work was undertaken.

The life-history of *Apoderus sissu* (Curculionidae) a leaf roller of *shisham* (*Dalbergia sissoo*) has been commenced.

Borers of Indian Timbers.

The general survey of the borer fauna of forest trees and of the range of food-plants of the individual species of borers was continued. Material came chiefly from Assam and Bengal.

In Kalimpong division, Bengal, 13 species of trees were felled and exposed for a comparison of the effects of removing the bark from logs and leaving it intact. It was found that some species of trees are not liable to attack during the half year that includes the cold season, and that of other species liable to borer attack some are protected by leaving the bark intact, others by removing it immediately after felling. A similar project has been started with 30 species in Jalpaiguri division, Bengal.

Timber of *Bombax malabaricum* can be protected by removing the bark but when required for use in the manufacture of matches it is necessary to retain the bark. The value of treating the bark with creosote, crude petroleum and furnace oil was tested. None of these measures gave complete protection although each of the oils eliminated certain groups of borers.

Marine borers were studied at Beypore and Kallai, South Malabar, where the incidence of damage of *Teredo* and *Martesia fluminalis* varies with the location of the depot with reference to the salinity of the water. It was found that timber may be stored in tidal waters for a period of six months from the beginning of June to the end of December without any damage of commercial importance occurring. But that logs left in the water or newly immersed between January and May begin to be seriously affected by *Martesia* and less so by *Teredo*. In three months a penetration of about an inch depth may be expected.

Parasites and Predators.

Parasites of teak defoliators. The newly recorded species of parasites and hyperparasites include *Apanteles hyblaea, Cedria paradoxa, Chelonella* sp. (Braconidae); *Brachymeria euploeae,* (Chalcidae); *Echthromorpha notulatoria, Mesochorus plusiaephilus* (Ichneumonidae); *Actia hyalinata, Cadur-*

cia zetterstedti, Carcelia kockiana, Dolichocolon orbitale, Eutachina civiloides, Exorista heterusiae, Hapaliolaemus machaeralis, Nemorilla floralis, Ptychomyia remota, Sturmia inconspicuella, S. nigribarbis, S. parachrysops (Tachinidae).

The following species are parasites of both *machaeralis* and *puera; Elasmus brevicornis* (Elasmidae), *Ptychomyia remota* and *Sturmia inconspicuella* (Tachinidae).

Nine species of teak defoliator parasites are known from other hosts.

Predators of teak defoliators.—Several species of Mantidae which are fairly general feeders have been studied including *Creoboter urbana, Deiphobe* spp., *Ephestiaula intermediana, Hierodula westwoodi.* The life-cycles are either annual or two per annum, the adult mantis is long lived and the nymphs feed actively throughout the year except in regions where there is a cold season. Food is taken at the rate of one caterpillar per day or every second day.

An account of the biology of the Mantidae is in the press as an *Indian Forest Record.*

The life-histories of a Reduviid bug and of a spider are under observation. The Melyrid, *Idgia melanura,* is predacious in the larval stage on *machaeralis.*

Termites.

The investigation of the seasonal incidence of soil termites at Dehra Dun in relation to the factors of climate, food-supply and protection was concluded, and the results were applied to methods of comparing the efficiency of treated and untreated timbers in relation to termite attack. A technique was developed for the comparison of natural resistance, preservative efficiency and durability under experimental conditions, valuations of potential durability under conditions of use being impossible. The methods involve exposure of closely arranged test-pieces and baits in small plots, results being expressed in terms of useful life (durability), unattacked life and average density of termites per test-piece at the end of a fixed period (resistance). For preservative efficiency tests parallel experiments with material in covered trays are recommended. An account of the methods of testing the susceptibility of timbers to termite attack is in the press as a *Forest Record.*

A comprehensive article on control measures suitable for use against termites injurious to forest buildings, nurseries regeneration areas, and living trees was published in the *Indian Forester.* Judging by the sale of reprints of this article in various parts of the world it has served a useful purpose.

General Insectary Work.

During the year 194 consignments of attacked material and insect specimens were received from various forest divisions in India for identification, etc. In the Insectary 58 cages were discontinued and 552 cages were in progress. The total number of insects bred out was 57,964 and of these 15,676 were set and labelled.

Life-history studies were carried out on defoliators of *Acacia arabica*, *Albizzia procera*, *Cupressus* sp., *Eugenia jambolana*, *Kydia calycina*, *Mallotus philippinensis*, *Pinus longifolia*, *Santalum album*, *Shorea robusta*, *Terminalia tomentosa*.

The biology of gall making Psyllidae was almost completed.

Advice was given on the introduction and propagation of cochineal insects for the destruction of prickly pear and an article was published in the *Indian Forester* on the subject.

Systematic Entomology.

The insect collection now contains 13,587 different species of insects, 287 species having been added during the year. The collection of immature stages has been greatly increased and particular attention has been given by the Systematic Entomologist to the classification of coleopterous larvae; two *Records* on the subject are in press. It is of interest to note that insect specimens sent with enquiries by forest officers are most frequently in the larval stage; although a great proportion of coleopterous larvae can now be accurately identified, most lepidopterous larvae are unknown and a collection of these is being built up with a view to study and classification.

As in former years numerous specialists have assisted in the classification of our collection of adults, and have described Indian species in many scientific publications. Especial acknowledgments are due to the specialists in the British Museum, to the Imperial Bureau of Entomology under Sir Guy Marshall and to Dr. T. E. Snyder of the United States Bureau of Entomology. The latter has studied and classified a very large collection of Termitidae, which had remained untouched for many years as no other specialist would undertake the work.

A paper on certain African beetle larvae of economic importance, prepared at the request of the Government Entomologist, Uganda, has been published in London.

The Forest Entomologist continued the study of Oriental Scolytidae and Platypodidae (43) including the identification of the material in these families collected by the Pacific Entomological Survey. Several reports were completed in the series Entomological Investigations on the Spike

Disease of Sandal (44) bringing the number sent to press up to twenty-four.

Tours.—By Dr. Beeson to timber mills and depots in Bombay, Madras, and Calicut; to Nilambur, Madras and to Coorg in April; to Bangalore (Spike Conference) in April; to Kalimpong, Bengal in October; to Ranchi (Lac Cess Committee) in October and March; to Lansdowne, United Provinces in February. By Mr. Gardner to Chakrata, United Provinces, in April. By Mr. N. C. Chatterjee to Nilambur in April-May; to Kalimpong, Kurseong and Jalpaiguri, Bengal in September November and March; by Mr. Dover to North Salem, Madras in May; by Mr. Bhatia to Chakrata, United Provinces in April and June; to Lansdowne in February. By Mr. S. N. Chatterjee to Nilambur and Coorg in April.

Museums.—The entomological museum continues its steady growth, the principal accessions were 206 specimens of damage to timbers by borers. Specimens of reptiles and amphibia were added to the zoological museum. A set of exhibits was prepared for display at agricultural or industrial exhibitions in the provinces.

Library.—192 books besides periodicals were added to the Zoological Library during the year.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

1. *Research.*

(*a*) Work in connection with the preparation of a hand lens key for the identification of the important commercial timbers of the Punjab was completed and is now in the press. In this bulletin, a full macroscopic description of various timbers, as well as short notes on their strength, seasoning properties, durability, working qualities, and supply and uses have been given. As these notes are the latest available for the timbers in question, it is hoped that the bulletin will prove useful to all interested in the timber-trade.

(*b*) Studies in the formation of growth rings in the woods of *Acacia catechu*, *Bombax malabaricum*, *Eugenia jambolana*, *Pinus longifolia*, *Shorea robusta*, *Tectona grandis* and *Terminalia tomentosa* were continued during the year. While making a critical examination of the wood blocks of *Terminalia tomentosa*, a hitherto undescribed type of parenchyma distribution was discovered. It was found that the so-called terminal parenchyma cells of *Terminalia tomentosa* are not really terminal but initial. Since this type of parenchyma distribution is apparently something new, a short note on the subject was published in *Nature*, Vol. 133, p. 215, February 10, 1934, to bring the matter to the attention of plant anatomists and wood technologists in different parts of the world. During the coming year, the remaining species will be critically studied.

(*c*) Research on the anatomical study of the wood of Indian Dipterocarps was continued during the year. 164 specimens were cut, of which 94 specimens were studied and their anatomical data taken down.

More specimens will be cut and studied, during the coming year.

(*d*) Experiments in connection with the improved method of softening micro-blocks in hydrofluoric acid were completed with success. Tropical timbers generally, being hard, require softening with hydrofluoric acid before any thin section can be cut. Most of the hard Indian timbers used to take about 6-8 weeks to soften, which is a long time, especially if the identification required is urgent. During the last 2 years experiments have been carried out on various timbers with a view to shortening the time required for softening. Ultimately this difficulty was overcome by using a pressure cylinder similar to that used by Lodewick for his "shorter celloidin method," but some modifications were necessary to suit the present work. The results obtained have been very satisfactory. Timbers which used to take 6 weeks to soften can now be

softened under pressure in a week's time, and those taking 8 weeks in 10-15 days. Details of the new method have been published in the *Annals of Botany* for January 1934.

(*e*) The study of the different varieties of *Terminalia tomentosa* (laurel) was continued during the year. All laurel trees do not have the good figured wood which usually fetches a very high price in the foreign market, in fact this figured wood is rather rare. The idea underlying this research was to find out whether good figured wood is confined to certain varieties of laurel or not and to discover whether such varieties can be differentiated botanically, so that seed from such trees could be used for regeneration purposes. Burma, Madras and Bombay are interested in this problem.

(*f*) To study the relationship between the anatomical structure and physical properties in common commercial timbers of India, work has been started with *Tectona grandis* (teak) from Burma. Ninety-one specimens have been received representing wide ringed heavy teak, normal teak and wide ringed light teak. These specimens are also being tested in the Timber Testing Section to find out their strength values.

(*g*) A study of the woods of the Indian *Meliaceae* (Mahogany family) has been started. Wood blocks are being prepared for cutting sections.

2. *Identification of Woods.*

As usual, a large number of timbers were received from various sources for identification. Among these there were one or two of historical interest. The Inspector General of Forests while on tour in Andaman Islands obtained a small piece of wood from a British sailing ship which was said to have been wrecked 70 years ago and had finally drifted into a mangrove swamp. The wood was very much discoloured and distorted and on examination was identified as European birch. On another occasion a small piece of wood from the gate of the Purana Killa at Delhi was sent for identification. It was found to be a perfectly sound piece of sal (*Shorea robusta*). In this connection it is interesting to note the following :—" Purana Killa was built or restored by the Emperor Humayun in 1530 and was abandoned shortly after his death in 1556. After this date no one would have been likely to repair the gate ; so that this sal gate has fulfilled its purpose for more than 400 years."

The total number of timbers identified during the year was about 300.

3. *Examination for Fungus.*

Various enquirers sent samples of wood suspected of having been attacked by fungus. The number of specific enquiries replied to in this connection was 55.

4. *Special Enquiries.*

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for several business firms. In this connection 123 wood specimens were examined.

5. *Accumulation of Anatomical Data.*

In the course of routine work, over 80 data sheets were filled up and filed for future reference.

6. *Collection of Authentic Wood Specimens.*

(*a*) In India :—Several authentic wood specimens were received for the standard collection.

(*b*) From abroad :—During the year altogether 190 wood specimens were received from the Fan Memorial Institute of Biology, China ; the Director, Forest Products Laboratory, Princes Risborough, England ; East Africa, South Africa and the Federated Malay States. To the donors our sincere thanks are due for helping the Forest Research Institute to make a complete collection of the commercial timbers of the world.

7. *Distribution of wood specimens.*

In response to requests from abroad and from various parts of India, 776 samples of timber were sent out to interested inquirers.

8. *General.*

Short courses in Wood Technology were given to the following officers :—

(*a*) Mr. H. M. R. Morse, Works Manager, North-Western Railway.

(*b*) Mr. C. R. Grey, Assistant Works Manager, North-Western Railway.

(*c*) Mr. D. Mukerjee, Professor, Ceylon Technical College, Colombo.

(*d*) Mr. R. M. Mubayi, Student Sleeper Passing Officer, Eastern Group, Calcutta.

Over 70 photomicrographs were sent to various persons interested in wood identification.

9. *Publications.*

See Appendix I.

Timber Testing Section.

1. *Staff.*

The work of the Timber Testing Section has of necessity been slowed down considerably by the reduction of staff consequent upon the retrenchment which accompanied the financial depression. In spite of this a considerable amount of work has been done and a reasonable balance maintained between tests and computation work.

2. *Special Investigations.*

(*a*) The study of the influence of friction on the results obtained with the standard shearing test tool was continued. A large number of matched specimens were tested in the standard tool and in a specially constructed tool with roller bearings. It was found that the influence of friction on the observed results was negligible, far greater variations being introduced by the shape of the test specimen and by the manner in which it was held in the tool. Sufficient data have been obtained and studied to indicate that the standard method of testing shearing strength in wood yields very useful results which are suitable as a basis of comparison between species.

(*b*) The study of the effect of wood coatings in retarding the passage of moisture was discontinued on account of shortage of staff and the necessity of employing them on other work. The results obtained were inconclusive but indicate that most wood coatings, as commonly used, do not develop their full waterproofing capacity because insufficient material is applied and the coatings are not truly continuous. There was also evidence that lacquer, cellulose and varnish coatings, if applied in sufficient quantity and formed into a continuous coat, very greatly retard the passage of moisture.

(*c*) Tests were continued on glue joints supplied by Ground Engineers through the Inspector of Civil Aviation. It is gratifying to note that it has now become a comparatively rare occurrence for a Ground Engineer's work to fail to come up to specification.

(*d*) Tests were made to investigate the physical condition of a teak sole bar taken from a railway wagon which had been damaged in derailment. It was found that, though the bar had in the first place been made of poor quality teak, the strength was sufficient for the purpose for which it had been used. There was strong evidence that the breakage of the sole bar had been the result of abnormal stresses caused by the derailment.

(*e*) A few tests were made of timber connectors such as are used in modern construction abroad. It was found that these connectors very materially improve timber joints. It was especially noted that babul

(*Acacia arabica*) coned dowels of the Kubler type, if properly designed and applied, are easy to fit and produce excellent joints. These connectors not only increase the strength of the joint but, a matter which is often of greater importance, very considerably reduce the distortion of joints under moderate loading.

(*f*) A series of tests was made to compare the mechanical properties of very wide ringed (fast grown) teak with those of normal teak. While the final conclusions must await the report of the Wood Technology Section on the structure of the wood, the mechanical tests indicate that, though rapid growth in ring porous woods is usually accompanied by the production of strong tissues, there is an optimum beyond which increased rate of growth in teak may be accompanied by reduction in strength. It also appears that in teak of extremely rapid growth the weight of the wood may depend more on the presence of infiltration products than is normally the case. No seriously defective material, however, was encountered except when the growth rate was excessively rapid, and material having 4 rings per inch or more was found to be of good quality. This must not be taken to mean that extremely slow growth on the other hand is good. Very slowly grown teak is usually of inferior quality also.

(*g*) A few tests were made to compare the strength of solid wood with that of plywood. When used as panels the 3-ply wood resisted practically three times the load carried by an equal thickness of solid wood. Tested in the same way 5-ply panels carried more than four times the load which could be carried by solid panels of the same thickness.

(*h*) Plywood boxes of hollong (*Dipterocarpus macrocarpus*, Vesq.) prepared by a firm in India were submitted to strength tests. The results obtained with these boxes were at least equal to, (in some cases better than), results obtained with imported plywood boxes.

(*i*) A new type of collapsible packing box designed and built at the Forest Research Institute was tested and gave promising results. This work is still engaging the attention of the Wood Workshop Section.

(*j*) The Officer in Charge was placed on special duty to conduct a study which should lead to the preparation of grading rules for Burma teak. A visit was paid to Calcutta and Rangoon and the position discussed with railway officers and teak dealers. A report was written on the information obtained, and arrangements were made to collect data over a period of some months in order to have reliable facts and figures on which subsequently to base grading rules.

3. *Routine Testing.*

In spite of the small staff now employed, work was vigorously prosecuted under Project No. 1 (Standard Tests of Small Clear Specimens)

and Project No. 2 (Standard Tests of Structural Timbers). Routine testing was also done on glues, ply woods, containers, etc., in co-operation with the Wood Workshop Section.

No. of species tested during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	7	2	4	
Project 2	3	3	..	
Project 0 under various sub-heads	..	..	..	36 consignments.
Tests of glue joints for aircraft	..	..	..	33 consignments.

No. of species computed during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	7	2	5	
Project 2	3	3	..	
Project 0 under various sub-heads	..	..	..	42 consignments.
Tests of glue joints for aircraft	..	..	..	33 consignments.

Over 12,000 mechanical tests and nearly 13,500 physical determinations were made during the year. Besides routine computations numerous tables and graphs were prepared for publication and for answering enquiries. The work started last year in the preparation of graphs for the determination of the annual cost of sleepers was completed. In connection with the special shrinkage study 9,000 observations were recorded during the year: these results indicate that under climatic conditions in Dehra Dun the shrinkage from the green to the air-dry condition is approximately half the total shrinkage from the green to the oven dry condition, and that the method of treatment, except at the very start of seasoning, has no appreciable effect on the result.

4. *Publications.*

See Appendix I.

5. *Technical Notes and Advice.*

The number of technical notes and letters of technical advice was somewhat reduced during the year on account of the Officer in Charge being absent on leave during part of the year. In spite of this, 99 technical letters and notes were issued on various subjects among which the following may be mentioned :—

1. Wood for cross arms on transmission lines.

2. Effect of preservative treatment on *Terminalia tomentosa* (not deleterious).
3. Wood for pick-axe helves.
4. The relative strength of heartwood and sapwood.
5. Wood for aeroplane spars.
6. Wood for cart wheels.
7. Wood for machine bearings.
8. Wood for spring boards.
9. Indigenous substitutes for hickory.
10. Indigenous substitutes for ash in bent work.
11. Working stresses and specifications for transmission line poles.
12. Timber for boat building to be used in salt water.
13. Information concerning flooring timbers.
14. Bobbins.
15. Sports goods.
16. The use of sissoo in railway carriages.
17. Framing of grading rules for structural timber and for lumber.
18. Timber for decking.
19. Shoe lasts.
20. The strength of wooden sole bars in railway wagons.
21. Timber for shuttles, tool handles, camera stands, folding chairs and sports goods.
22. Barrel making.
23. Modren connectors for timber structures.

Realization of the value of strength data and general information as to the suitability of various indigenous species for particular uses is gradually increasing, and there is consequently a growing appreciation of the importance of the scientific study of Indian woods for which the Forest Research Institute is responsible.

Wood Seasoning Section.

1. *New Method of Kiln Drying.*

During the year considerable progress was made with the new method of kiln drying described in detail in last year's report. A number of kiln charges of various species were dried, and in most cases satisfactory results were obtained. With laurel (*Terminalia tomentosa*), sissoo (*Dalbergia sissoo*) and toon (*Cedrela toona*), it has been possible to shorten the time of drying, reduce the consumption of steam and of electric

current, and obtain kiln-dried material practically free from any permanent set without any intermediate steaming operations.

It is interesting to note that a charge of one inch thick laurel (*Terminalia tomentosa*) planks was dried from the green condition to 10 per cent. moisture content in 12 days. This is perhaps the shortest time in which this timber has ever been kiln dried. The condition of the timber at the end of process was extremely satisfactory, there being no appreciable increase in degrade. The final tests showed the absence of any case-hardening stresses, as well as a uniform distribution of the moisture in the wood. The total consumption of steam was 13,256 lb. for drying a charge of about 165 c.ft. of laurel, containing about 32 lb. of water per cubic foot. The consumption of steam per pound of moisture evaporated from the wood comes to about 3 lb., which is a much lower figure than that of any previous results.

A further advance has been made in that it was found that during the cooling period it is not necessary to work the fans continuously. As a matter of fact, if the circulation is stopped, there is a tendency for the humidity to rise in the stack, which helps in raising the moisture content of the surface layers, and thus brings about a better outward diffusion of moisture, and at the same time more effectively neutralizes any stresses developed during the heating period. It has been found that a short period of fan circulation, say for 2 to 3 minutes every half hour during the cooling stage, is quite sufficient. In order to equalize the humidity conditions within the stack, it is useful to instal some dampers in the baffle walls of the fan system, which can be opened during the cooling period, thus taking full advantage of the thermal circulation within the stack. It may be stated that for a small sized kiln having a capacity of about 200 c.ft. of wood, and working with a 2 H. P. electric motor, the current consumption has been reduced from about 20 units per day to only about 2 to 3 units per day by using this new method.

Everything has not, however, gone quite smoothly with this new method of kiln drying. It has been found that the kiln walls, on account of their porous nature, upset the drying conditions inside the kilns. If drying is done in a kiln of non-porous construction, say of iron-sheeting, the relative humidity tends to reach the saturation point at the end of the cooling period. With brick kilns this is not so. The relative humidity of the air at the end of the cooling period in the kiln is always lower than it really should be; with the result that there is a tendency for the surface layers to dry, and thus set up a moisture gradient in the wood. This effect is more pronounced in small kilns, where the quantity of wood is very small compared with the wall area.

Similar difficulty has been found in constant humidity chambers built of brick-work and concrete. With pure water in trays over which

the air continuously circulates, it has not been possible to attain a humidity higher than 92 per cent. With saturated salt solutions, the relative humidity obtained is always lower than the values given in the International Critical Tables.

Work is now in progress to determine conditions of drying which would be applicable to ordinary kilns of brick and mortar construction. Further studies are being made of the movement of heat and of moisture during the various stages of heating and cooling, because a knowledge of these phenomena is very necessary in order to be able to specify the maximum temperature and the length of heating period necessary for any particular timber.

At the Institute at Dehra Dun, there are two miniature and two large sized kilns equipped with internal fans for air circulation and during the period the boilers were working (about 7 months in the year, owing to reduction in budget grants), all four kilns were kept busy. In all, 25 charges of timber were kiln-dried, and useful data have been obtained on the drying of various species.

2. *Kiln Drying with Ozone.*

It has now been definitely established that there is no benefit whatsoever in adding ozone to the circulating air in a kiln. Experiments were carried out with matched specimens of the following four species of wood, which were dried with and without the addition of ozone at a relatively low temperature (35°C), so as to avoid any decomposition of ozone which might take place at high temperatures :—

1. *Anogeissus latifolia.*
2. *Hardwickia pinata.*
3. *Palaquium ellipticum.*
4. *Schima wallichii.*

It was found that the addition of ozone did not have any effect on the rate of drying or on the shrinkage of any of the species under test. The claim is made by interested parties that timber dried with ozone is more stable, *i.e.*, less prone to subsequent swelling and shrinkage when exposed to various atmospheric humidities. This claim has been definitely disproved, and it has been clearly brought out by experiments that not only is the subsequent swelling and shrinkage the same in pieces dried with or without ozone, but the rate of change with time *i.e.*, the hygroscopicity is also not affected. A detailed report on the experiments is under preparation.

3. *Drying under Vacuum.*

No detailed work was carried out with vacuum drying, except one small test to verify the claim made by a Swedish firm. It was held by

them that the application of a sudden vacuum to green wood brings out the liquid moisture held in the capillary spaces of the wood. They suggested a plant consisting of two cylinders of equal size, one of which is under vacuum, and which is then connected to the other at atmospheric pressure, which would mean a sudden application of vacuum of not more than 15 inches. This idea was tried with the only difference that 2 cylinders of unequal size were connected. The large cylinder, about 200 times the size of the small one, was exhausted till it showed a vacuum of 26 inches. The small cylinder contained pieces of wood fully saturated with water, and when the two were connected, it was found that there was hardly any change in the vacuum gauge on the big cylinder, while that on the small cylinder showed a vacuum of 26 inches. Even under these conditions, not even the smallest amount of moisture was found to have come out of the fully saturated pieces of wood of any of thespecies tested. It is not uncommon that, for the sake of advertising, various firms all over the world put up such quasi-scientific and plausible looking claims, for which there is no experimental justification whatsoever, and it is only by testing such claims that the truth can be discovered. Many such claims have been tested at the Forest Research Institute and any one interested in such new and plausible ideas would do well to consult the Institute before they embark on any new venture.

4. *Air-Seasoning.*

Small air-seasoning experiments were started on about a dozen species, and observations were continued on all the species stacked last year for air-seasoning.

The most important piece of work done, however, was the writing up of a " Manual on the air-seasoning of Indian Timbers" which includes detailed seasoning characteristics of 120 of the more important indigenous woods. The Manual will be published during the coming year.

5. *Seasoning of Softwood Railway Sleepers.*

Another air-seasoning experiment on softwood railway sleepers in co-operation with the Punjab Forest Department and the North Western Railway was started during the year at Dhilwan in the Punjab, with the object of finding out the most suitable method of stacking, the time required for proper air-seasoning, and the effect of end-coating of sleepers. Three species, namely deodar (*Cedrus deodara*), chir (*Pinus longifolia*) and fir (*Abies pindrow*) were included in the experiment and the stacking was done in December 1933. At the end of March, all the sleepers were inspected carefully for any degrade during the period of seasoning, and a large number of moisture content tests were taken. The experiment is still in progress, but the results obtained so far are very conclusive and

interesting, and based on them the following recommendations can be made :—

(*a*) All softwood sleepers should be end-coated with thick tar or some other suitable material as soon as possible after the sleepers are taken out of water.

(*b*) Deodar, and very likely fir, can be stacked in close crib manner after end-painting, provided the stacks are protected against too rapid drying from the ends and the top. Chir sleepers should be stacked in the 1 and 9 method on account of their liability to fungus attack.

(*c*) Seasoning should be continued till the sleepers are fully dry. The exact time will be known at the end of the experiment, but it is, in any case, much longer than 3 months.

6. *Laboratory Experiments.*

(i) Methods of moisture determination. The work on this item was completed during the year, and a paper has been written up for publication. The important conclusions are :—

(*a*) For all practical purposes, the oven drying method of determining moisture-content by drying test-sections about ½-inch thick along the grain in an oven at about 100°C gives reliable results, except in the case of timbers containing large amounts of volatile constituents, such as deodar.

(*b*) In the case of woods containing a large percentage of volatile constituents, the distillation method should be adopted, using water-saturated xylol, and reflux distillation if possible.

(*c*) Volatile constituents in deodar may vary from 1½ to 10 per cent., the average value being about 5½ per cent.

(*d*) Chir, gurjun (*Dipterocarpus* spp.) and *pali* (*Dichopsis elliptica*) contain about 1 per cent. of volatile matter.

(*e*) Thingan (*Hopea odorata*) and teak contain only negligible quantities of volatile substances, if any.

(ii) Shrinkage and hygroscopicity experiments : Work on the five species taken up last year was continued, and two more species were taken in hand. It has been found that shrinkage and hygroscopicity are not at all appreciably affected by any of the various treatments, such as steaming, soaking in water, boiling, kiln-drying, etc. Experiments have been started on the impregnation of wood with various substances, such as sugar, glycerine, sodium silicate, etc. It will be interesting to know definitely what effect, if any, these exert on the shrinkage and swelling of wood.

(iii) Moisture movement with heat: Working with small cylinders of wood, it has been definitely established that moisture moves in the direction of the heat flow in wood. This is an important discovery and work is in progress to determine a relation between the two. The fundamentals of the new process of kiln-drying, described under item 1, are based on the establishment of a temperature gradient from the inside to the surface during the cooling stage, which would tend to bring the moisture out from the centre.

7. *Enquiries.*

During the year 28 enquiries were replied to on various subjects relating to the air and kiln-seasoning of timber. Detailed instructions for the operation of seasoning kilns were supplied to two firms in Assam and Bengal respectively, and specifications for a timber drying-kiln were sent to a timber merchant at Rawalpindi.

8. *Training.*

An officer from the Gramophone Co. Ltd., Calcutta, was trained in the operation of seasoning kilns. Mr. Mubayi, Assistant Sleeper Passing Officer, Eastern Group, was given training in the seasoning of railway sleepers. Mr. D. Mukerji, an officer of Ceylon Government, also spent a week in the Section, picking up general information relating to the seasoning of timbers.

9. *Publications.*

" A Manual on the air-seasoning of Indian Timbers " by Dr. S. N. Kapur, Officer in Charge, Seasoning Section, has been prepared and submitted for publication.

A paper on the " Study of some common methods of determining moisture n wood, with particular reference to woods containing volatile constituents " by S. N. Kapur and D. Narayanamurti has been written up and will be published shortly.

10. *Tours.*

In connection with the air-seasoning experiment on softwood railway sleepers in the Punjab, a number of visits were paid to Dhilwan by Dr. S. N. Kapur, and Mr. Azizul Rahman, Upper Grade Assistant, Seasoning Section.

Wood Preservation Section.

Mr. S. Kamesam was in charge of the Section throughout the year except for a period of about 3 months when he was absent on leave.

1. *The ASCU Wood Preservation Process.*

The most important achievement of the section during the year under review was the perfection of a wood preservative consisting of arsenic (*As*) and copper (*Cu*) compounds which can be employed in aqueous solution for injection into wood in steel pressure cylinders. It has been called " ASCU," and is a logical development of the Falkamesam process. Patents for the process have been granted to the inventor, Mr. S. Kamesam (Officer in Charge of the Section) in Great Britain and India ; patents are pending in the United States of America, Canada, Mexico, Argentine, Brazil, South Africa, and Australia, but the Indian Government have reserved for themselves the right to use the process, as and when required, free of charge. It is the first wood preservative containing arsenic and copper (compounded in the most effective proportions) which appears to ensure a high optimum degree of fixation, individually, of arsenic and copper in wood. In addition, despite the presence of copper, it is said to be entirely non-corrosive to steel, iron, and brass, and to be perfectly stable in contact with these metals. The previous use of arsenic and copper as wood preservatives has been extensive and well-known. Even at present, copper sulphate is employed for treating annually a few lakhs of wooden telegraph and telephone poles in France. Recent experiments conducted by this Section indicate that, for a unit of money, arsenic affords the maximum toxicity against wood destroying fungi, and a high degree of protection against termites, while copper is even superior to arsenic as far as termites are concerned.

During the year, experiments based on a new and accelerated technique for testing the relative efficacy of wood preservatives, indicated that a 4 per cent. solution of arsenic and copper in the proportion of 1 to 3 corresponds (on the basis of wood preserving efficacy) to undiluted 100 per cent coal tar creosote, so that, as regards relative cost, if a gallon of creosote costs on the average about a rupee, ASCU costs only about $2\frac{1}{2}$ to 3 annas. In Dehra Dun creosote is not available for less than about Rs. 2 per gallon.

2. *The Railway Board Special Committee.*

During May, 1933, an *ad hoc* committee was appointed by the Railway Board, with Sir C. V. Raman, F.R.S., N.L., in the chair. The other members were Messrs. J. M. D. Wrench and A. F. Harvey, Directors of Engineering, Railway Board, Mr. R. H. Irani, Senior Government Inspector of Railways, Bombay, and Mr. R. Sephton, Chief Engineer, Great Indian Peninsula Railway. The Committee sat for three days at Dehra Dun investigating the claims of the Falkamesam process which Mr. Kamesam has now improved upon with the *ASCU* process which ensures not only the fixation of arsenic (as in Falkamesam) but of copper

also. Although the committee has not yet submitted their report, the chairman, on the basis of experiments made under his supervision at the Indian Institute of Science, Bangalore, has written to the Forest Research Institute that the inventor's claims regarding the fixation of arsenic in wood were " entirely substantiated."

The Director General, Posts and Telegraphs, Government of India, deputed Mr. M. N. Crawford, Director of Telegraph Engineering, United Provinces Circle, to attend the deliberations of the committee, and to report on the advisability of using treated wood in place of galvanised iron tubular poles, and also to report,—if treated wood poles are more economical,—as to the kind of chemical treatment that should be given to the poles for protection against decay and termite attack. It is understood that Mr. Crawford reported that he was not only convinced that properly treated wood poles would be more economical than iron poles, but that the ASCU process would be the best process to adopt for the Posts and Telegraphs Department.

3. *Emulsion of Falkamesam and Crude Oil.*

Several prominent railway engineers are of opinion that, if the Falkamesam or the ASCU process is to be adopted for treating railway sleepers in India, a supplementary anti-splitting impregnation of crude oil into wood would be necessary. For combining crude oil injection with the antiseptic impregnation in one movement, several experiments were made to determine whether a suitable emulsion of the oil and the solution could be made. Such an emulsion should be fine and stable enough to penetrate at least the sapwood of chir pine without the oil or the water separating unduly during the process. Viscosity observations made on emulsions containing different proportions of crude oil and the antiseptic solution were made; the effect of the degree of emulsification on the viscosity of the resulting emulsion was also studied. Although fine emulsions with the fluids could be obtained, it was noticed that the preservative got decomposed after standing for a short time, as part of the chemicals was precipitated. A single movement process involving the injection of Falkamesam and crude oil did not therefore appear to be practicable, and if an oil treatment is considered necessary, in addition to an ASCU or Falkamesam treatment, it will be necessary to do this separately. A dipping treatment in crude oil will probably be quite sufficient.

4. *A New Method of Accelerated Service Test with Wood Preservatives.*

During the year, a new method of testing wood preservatives in the antiseptic " grave-yard " was introduced. This bids fair to yield reliable results of considerable value in a very short time. Instead of employing sticks (even as small as an inch square in cross-section) impregnated

with the preservative under test, fresh rotary-cut veneers of a very perishable wood like semul (*Bombax malabaricum*) are used. The veneers are only a sixteenth of an inch thick, an inch wide and six inches long. They are treated in an open tank, ensuring a complete penetration of the preservative fluid. Before the rainy season starts, they are placed in the Institute test-yard with half their length buried in the ground.

The superiority of the above method is based on the following considerations :—

(*a*) When a wood post placed in the ground is eventually destroyed by white ants or rot, the attack proceeds from one outer peripheral lamina to the next contiguous one inside. In veneer specimens, if the attack is confined to but a depth of 1/48 inch (a very small thickness) on either side, the middle 1/48 inch section has hardly any mechanical strength, so that it easily crumbles to pieces. Hence if the veneers are sound for a year, the concentration of chemical that has protected the veneer for that period may with reasonable safety be adopted in actual practice.

(*b*) As the test veneers should be preferably rotary-cut their surface is tangential and is, therefore, very similar to that of a round pole under service conditions.

(*c*) As the veneers are of a wood with large open pores, and are laid in the ground during the rainy season (at Dehra Dun the precipitation amounts to about 80 to 90 inches in about three months), and since the pieces are very thin and are exposed to the sun, the leaching and volatilisation conditions to which they are exposed can be taken as very severe. It may be noted also that the thin veneers are exposed on both their broad faces to leaching and volatilisation, whereas in a wood pole, the thin outer lamina is exposed to such conditions only over one face.

(*d*) As the buried pieces have practically only two dimensions, the precise extent of damage at the time of different inspections can be evaluated and recorded accurately, reducing the personal factor in such inspections to a minimum.

(*e*) The untreated controls are destroyed in a very short time in most cases, so that if the treated veneers in the same localities last for 9 months to a year, the treatment must have considerable merit.

5. *Veneers Tests Applied to Five Wood Preservatives.*

Creosote and four efficient inorganic wood preserving chemicals were employed in graded concentrations for test with semul veneers. The

four inorganic chemicals were deliberately chosen from those that offer a fair or a high degree of resistance to being washed out, or to evaporating from the wood into which they are injected. They consisted of (1) " fixed " copper (2) " fixed " arsenic (Falkamesam), (3) " fixed " arsenic and copper (ASCU), (4) copper arsenite, which can be used only in a dilute ammoniacal solution in open tank treatment. Six veneers for each concentration of the five wood preservatives (including creosote) were treated and two pieces of each (treated with the same concentration of chemical) were laid in three different localities. The tests have been in progress for about 9 months, and the veneers have been exposed to 70 to 80 inches of rainfall. The latest available results at the three different localities are remarkably similar. Also, the destruction of the veneers has proceeded progressively from those treated with the lowest concentrations to those with the higher concentrations (up to a critical limit) where there has been practically no further attack for some time. The ASCU wood preservative has so far given the best results for a unit of money. Some of the veneers treated with 40 per cent. creosote perished in even less than six months; such a concentration corresponds to 2 per cent. to 3 per cent. of ASCU which has already protected the veneers for over 9 months.

To determine the approximate quantities of the wood preserving chemicals noted above, for equivalent effectiveness (irrespective of the cost factor) in protecting wood against fungus and white ant attack, and in order to investigate the effect of species on critical toxicity concentration, $\frac{1}{8}$" sliced veneers of sapwood pine (*Pinus excelsa*) were treated with different concentrations of the chemicals and laid in the " test-yard " of the Section. Even after about 8 months, during which period they were exposed to about 50 inches of rainfall, very few of the veneers (compared with those of semul similarly treated) have been destroyed. The untreated controls perished in 2 to 3 months compared with those of semul which were destroyed in about a month.

6. *Small Scale Service Tests with Arsenicals and other Preservatives.*

In last year's annual report, a list of substances which were submitted to test with arsenicals and other wood preservatives was given.

The experiment has recently been closed, and the following indications may be deduced from the results :—

(*a*) Creosote, Falkamesam, copper sulphate (fixed or unfixed) and mercuric chloride gave the best results. Copper sulphate and mercuric chloride appeared to be the most effective against termites, but neither of these, *per se*, can be employed in pressure treatment.

(*b*) Arsenic in the trivalent form appears to be slightly better than in the pentavalent form.

(*c*) Of the other arsenic compounds tested, arsenic trioxide, colloidal arsenious trisulphide, and zinc-meta-arsenite, gave better results than Powell solution and Thanalith U, both of which exhibited a rather poor degree of resistance to fungus and white-ant attack.

(*d*) The least effective termiticides of the chemicals tested were sodium dichromate, zinc chloride, sodium fluoride and barium hydroxide.

(*e*) Fuel oil gave poor results. A piece of semul treated with 20 per cent. fuel oil was destroyed in less than 9 months. In the form of veneers, 20 per cent. fuel oil may be expected to give way in a few weeks for the same absorption per unit volume.

(*f*) Creosote fractions distilling at over 260°C were decidedly superior to the lighter fractions.

(*g*) Some of the creosote and crude oil (1 : 1) treated pieces were moderately or badly attacked although they were treated with a 20 per cent. solution of the mixture.

(*h*) Pieces treated with straight creosote were sound over an 8 per cent. concentration.

The size of pieces used in this test appeared to be too large, and had other disadvantages.

7. *Relative Efficacy of Wood Preservatives to Termites and Wood Destroying Fungi.*

Experiments are in progress to investigate this important question as, in most cases, wood is destroyed by the con-joint and synchronous action of termites and fungi. It has been found that generally a larger quantity of chemical is required for protection against white ants when the wood is initially fungus-attacked. As in practice, there is almost always a certain degree of fungus attack in wood, it becomes a moot point, especially where there is a danger of termite attack, as to whether toxicity tests should not be conducted with fungus-attacked instead of sound test specimens. There are a number of complicated aspects which require investigation in this connection, and a start in this direction was made. It is expected that results of some value will be reported in next year's report.

8. *Project IV and Grave-Yard Tests.*

Some of the *Parashorea stellata* sleepers from Burma were treated during the year.

During the year, the following were added to the standard grave-yard test of the Section.

1. Sundeala fibre board.
2. Sawdust and cement composition.
3. Creosoted sal pieces.
4. Fibre boards.
5. Insulation boards.
6. Shalco.
7. Standard canvas (treated).
8. Treated bamboo.
9. ASCU.
10. Wood oil.

Untreated specimens of the following species were added during the year :—

1. *Podocarpus wallichianus.*
2. *Artocarpus integrifolia.*
3. *Mallotus philippinensis.*
4. *Miliusa velutina.*
5. *Stereospermum xylocarpum.*
6. *Bassia butyracea.*

All the untreated specimens in the grave-yard were inspected twice during the year, and the treated pieces once after the rains. Reports were sent out to all Government authorities and firms interested.

Reports on the pieces of wood that were treated with different wood preservatives and shaken 20,000 times with water, and then laid in white ant infested ground in several parts of India, indicate the superiority of Falkamesam over other arsenical preservatives. ASCU, on account of its being a development of and an improvement on Falkamesam, may be expected to give even better results. All the Falkamesam-treated sticks planted in the grave-yard about twenty-two month sa go are intact. This is unique for a water-soluble preservative, as with none of the many other water-soluble preservatives tested, (except for copper arsenite), were the treated pieces all sound even at the end of one year.

9. *Tests against Marine Organisms.*

ASCU, Falkamesam and creosote-treated pieces with corresponding controls are under observation in the Calcutta, Bombay and Madras harbours. Available reports to date indicate the efficacy of the preservatives in question.

10. *Miscellaneous Work.*

In the chemical laboratory, although the Section carried on without the Chemist of the section for about six months, miscellaneous work of considerable importance was conducted by the two laboratory assistants. In the experimental wood preservation plant, fence posts, paving blocks, and other material were treated with several kinds of antiseptics for a variety of experimental and utilitarian purposes.

11. *Publications.*

1. Forest Bulletin No. 85 entitled " A record of the results obtained with experimental treated sleepers laid in the Indian Railways between 1911 and 1916 " was sent to the press.

2. The Officer in Charge of the Section was awarded H. E. the Viceroy's prize of Rs. 500 by the Institution of Engineers (India) for his paper on " A new principle in wood preservative impregnation with special reference to chir pine " ; the paper was based on some experimental work done in the Wood Preservation Section a few years ago.

Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other Sections, while the Officer in Charge devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 10,875 wood specimens for test purposes.

The Wood Technology Section was supplied with 33 Gamble and 620 hand specimens of 25 species.

486 orders of maintenance and routine work were booked, and 468 orders (including 65 from the previous year) were completed.

195 logs of the following species were converted in the sawmill :—

Podocarpus wallichianus (thitmin) for strength tests.

Mallotus philippinensis (*roini*) for strength tests.

Mimusops elengi for strength tests.

Miliusa velutina (*dom-sal*) for strength tests.

Castanopsis hystrix (*katus*) for strength tests.

Stereospermum xylocarpum (*vedang komai*) for strength tests.

Parishia insignis (red dhup) for strength tests.

Shorea robusta (sal) for strength tests.

Bassia butyracea (hill *mohwa*) for strength tests.

Vitex altissima (*milla*) for strength tests.

Dalbergia latifolia (Indian rosewood) for strength tests.

Xylia xylocarpa (*irul*) for strength tests.

Pterocarpus santalinus (red sanders) for strength tests.

Lagerstroemia lanceolata (benteak) for strength tests.

Terminalia tomentosa (laurel) for seasoning tests.

Hardwickia pinnata (piney) for seasoning tests.

Schima wallichii (needle wood) for seasoning tests.

Anogeissus latifolia (axlewood) for seasoning tests.

Dichopsis elliptica (*pali*) for seasoning tests.

Dalbergia latifolia (Indian rosewood) for general use in the Wood-Working Section.

Cedrela toona (toon) for general use in the Wood-Working Section.

Dalbergia sissoo (sissoo) for general use in the Wood-Working Section.

Mangifera indica (mango) for general use in the Wood-Working Section.

Pinus longifolia (chir) for general use in the Wood-Working Section.

Tectona grandis (teak) for general use in the Wood-Working Section.

Terminalia tomentosa (laurel) for test in the Wood-Working Section.

Grewia tiliaefolia (dhaman) for test in the Wood-Working Section.

Hopea parviflora for test in the Wood-Working Section.

Xylia xylocarpa (*irul*) for test use in the Wood-Working Section.

Anogeissus latifolia (axlewood) for test use in the Wood-Working Section.

Pinus longifolia (chir) for test in the W. P. Section.

Cedrela toona (toon) for veneer tests.

Dalbergia sissoo (sissoo) for veneer tests.

Artocarpus hirsuta (*aini*) for veneer tests.

Ougeinia dalbergioides (*sandan*) for veneer tests.

Chukrasia tabularis (chickrassy) for veneer tests.

Pterocarpus marsupium (*bijasal*) for veneer tests.

Dalbergia latifolia (Indian rosewood) for veneer tests.

Pinus longifolia (chir) for use in the Paper Pulp Section.

Dalbergia sissoo (sissoo) for flooring in the Forest Research Institute.

In addition to the above, 2,358 paving blocks were converted from old sleepers for flooring the timber godowns, 753 paving blocks were cut from sleepers for use in the W. P. Section, 350 maunds of firewood

were cut for making charcoal for briquetting experiments and for use in the new F. R. I. kiln, 200 ballies were converted into 430 posts for the Rangers' College, 4 sleepers were squared for the Wood Seasoning Section, 3 special test blocks (glued planks) were made for experiment in the Veneer Section, 1 plank of *Terminalia tomentosa* (laurel) was specially cut into five veneers, 7 planks of *Swietenia mahogoni* (mahogany) were cut into 14 veneers for general use in the Wood-Working Section, 1000 crossers were prepared from off-cuts for the Seasoning Section, and 7 lorry loads of firewood were cut for stock.

A large number of enquiries were received from various sources which were replied to.

Tests.

Tests on glues and plywood were carried out as follows and results submitted to :—

1. The Aircraft Inspector, Karachi, on samples of casco waterproof glue and casco No. 2 white glue.
2. The Divisional Forest Officer, Nowgong Division, Nowgong, on the conversion qualities of Nowgong town teak.
3. The Assistant Aircraft Inspector, Civil Aerodrome, Dum Dum, on a sample packet of ' held ' glue.
4. Messrs. Bird & Co., Calcutta, on *Dipterocarpus macrocarpus* (hollong) plywood.
5. The District Forest Officer, North Mangalore, on the working qualities of two samples of *Artocarpus integrifolia* (jack).
6. Master-General of the Ordnance Branch, Army Headquarters, Simla, on five plywood pieces of chir and deodar.
7. The District Forest Officer, Upper Godavari Division, Madras, on two logs of Godavari teak sent for green test under Project VIII.

General.

Experiments were also carried out with a view to finding a waterproof coating for the edges of plywood exposed to the elements. A report was issued.

Tests were carried out on the undermentioned glues supplied by Aircraft Inspectors :—

Casein Cement 3 V. 2.

Casco Waterproof Glue.

Casco No. 2 White glue.

' Held ' Glue (Liquid).

Logs of the following species were peeled for tests under Project VIII :—

Tectona grandis.

Swintonia floribunda.

Parashorea stellata.

Anisoptera glabra.

The number of species now tested under this Project amounts to about sixty.

Experimental ' Quickfold ' collapsible packing cases were made and supplied for trial to the Railway Board, Simla, and to the Inspector of Gun Carriages and Vehicles, Jubbulpore. This work is being continued.

Reports.

Reports on the working qualities of the undermentioned timbers were issued during the period under review :—

Podocarpus wallichianus.

Stereospermum xylocarpum.

An interim report on the work done up to the end of 1933 under Project VIII (testing of veneers and plywood) was written up before the end of the year and will be published shortly.

MINOR FOREST PRODUCTS SECTION.

1. *General.*

The Forest Economist is nominally in charge of this Section, and the total staff of the Section consists of one Upper Grade Assistant (Mr. Ramaswami), one laboratory assistant and 3 or 4 coolies. With such a staff it is evident that very little research work can be accomplished. The year under review has from a research point of view being practically wasted, as the time of the Assistant has been almost completely taken up in answering enquiries about minor products. The chief items of work undertaken by the Section are as follows :—

2. *F. R. I. Portable Charcoal Kiln.*

Scale drawings of the kiln were sent to various firms of manufacturers in India asking for quotations. They were informed at the same time that the Forest Research Institute would not take any part in the sale and that the main idea was to put the kiln on the market at the lowest possible price. The lowest quotation received was Rs. 535 each for an

order of not less than 12 kilns at a time, but it is possible that those who intend to use the kiln could get it made for less than this.

Great interest is being taken in the kiln by forest officers and charcoal contractors if the numerous enquiries received on this subject is any criterion. The working of the kiln was also demonstrated to two forest officers and to a charcoal contractor who came to the Institute for that purpose.

A note embodying details of and the results of the working of the kiln is under preparation.

3. *Charcoal Briquetting.*

Further large scale experiments on charcoal briquetting were handicapped for want of a charcoal grinding machine. A grinding machine was purchased towards the close of the year and more progress will be possible after its erection.

4. *Bamboo branches for umbrella handles.*

At the instance of the U. P. Forest Department and a firm of umbrella manufacturers, some experiments were started in conjunction with the Seasoning Section, to find out whether bamboo branches could be bent for use as umbrella handles. As material of the requisite size could not be obtained locally, the enquirers were asked to supply samples. It is doubtful whether large quantities of bamboo branches of a suitable thickness for use as umbrella handles could be obtained, as they have a tendency to taper too much, though they may be of the right thickness at the base.

5. *Minor Forest Products Garden.*

During the year, roughly half the area of the old Minor Forest Products' garden was handed over to the Forest Botanist for the new Botanical garden. At the same time the extensive nurseries of the Botanist will be used for the cultivation of medicinal plants in fair sized beds, to determine whether the yield and quality of such drugs can be improved by cultivation. This will form an important part of the work of the Minor Forest Products Section in future.

As regards medicinal plants already under cultivation in the garden, some seeds were collected from the *Artemisia maritima* plants sown last year, and these acclimatised seeds were again sown this year. Germination was poor, but enough plants have been obtained for planting this year. Propagation by stem cuttings was tried and found to be successful, but it is too early to pronounce any opinion on this till after the monsoon. Experiments have shown that *A. maritima* seeds stored for a year lose their power of germination.

Psyllium (*Plantago psyllium*, L.) which was sown in March during the previous year grew vigorously but failed to flower. Its cultivation was continued this year, the sowing being made in October-November. The growth was good and the plants were flowering and fruiting at the end of the year (March 1934), and it is hoped that the seeds will be ripe before the monsoon sets in.

A list of medicinal plants suitable for cultivation in the Minor Forest Products garden was prepared and sent to Lt. Col. Chopra, Professor of Pharmacology in the School of Tropical Medicine, Calcutta, for his opinion. The reply was received after the close of the year. About 2 dozen plants chosen from his list will be cultivated during 1934-35.

6. *Enquiries.*

Numerous enquiries dealing with sources of supply, collection, marketing, prices, etc., of various minor forest products were answered during the year, in fact this part of the work is now so heavy that it takes up practically the whole time of the only officer in the Section.

Paper Pulp Section.

1. *Experimental Factory.*

As a measure of fuel economy, the steam boilers were shut down at three different times during the year for a total period of about 16 weeks, necessitating suspension of work in the experimental paper factory.

(*a*) *Disintegration of bamboos.*—Experiments on the disintegration of bamboos in the Norris and Christy machine were continued during the year under report. It was found necessary to effect a number of modifications in the machine in order to obtain (without appreciable loss of the material as dust or fine particles) satisfactory chips, which could be completely digested in the factory. In the case of thick or solid bamboos it was found helpful to split the culms and partially crush the nodes prior to digestion. Experiments, to devise suitable means to effect this and also to determine the output of the machine, the power consumption, and the loss of material, etc., will be carried out next year.

(*b*) *Dendrocalamus hamiltonii* (*kokwa*) *bamboo.*—A few semi-commercial tests on this bamboo were carried out, employing the sulphate process by the fractional method. The tests appear to confirm last year's laboratory results as regards yield and bleachability. Further tests to determine the optimum conditions of digestion and to obtain the maximum yield of pulp are in progress. The present report is printed on paper made from this bamboo, which fact speaks for itself as to its suitability as a paper-making material.

(*c*) *Ochlandra brandisii* (*eta*) *and Melocanna bambusoides* (*muli*) *bamboos.*—Experiments on these bamboos were carried out to prepare special pulp suitable for artificial silk manufacture. As consistent and markedly improved results, as regards alpha cellulose content, were not obtained, it is proposed to repeat the experiments.

(*d*) *Saccharum spontaneum* (*kans*) *grass.*—A number of experiments were carried out on this grass, with the help of the rod mill, to obtain easy bleaching pulp, but the pulp obtained was not free from shives and the yield was also low. It is proposed to repeat the experiments, modifying the processes of digestion and bleaching, if necessary.

Efforts to produce wrapping paper from the grass were also unsuccessful, as the paper obtained was full of shives and poor in strength.

(*e*) *Flax waste.*—Laboratory experiments carried out during the year before last had indicated that this material was excellent for paper-making purposes. Semi-commercial tests were, therefore, undertaken to confirm the laboratory results. It was found necessary to grind the material after predigestion. The rod mill in the factory, however, proved unsuitable for the purpose, as the woody cores, embedded in the tangle of long fibres, escaped thorough crushing, with the result that the bleached pulp contained some shives, though its yield was quite satisfactory. It is proposed to arrange for the predigestion and the grinding of the predigested material at the paper mills at Lucknow, where facilities exist for the purpose.

(*f*) *Pinus longifolia* (*chir*).—Experiments were carried out for the production of (1) kraft paper and (2) bleached papers from this pine. The material produced an excellent kraft paper, but the bleached pulp obtained from it was not clean and was also low in yield. Experiments on this material will be continued next year.

(*g*) *Manufacture of paper.*—About 1¼ tons of writing, printing, type and kraft papers, and mounting and drying boards, were manufactured in the factory during the year and supplied to the various offices of the Forest Research Institute and College.

2. *Laboratory.*

(*a*) *Preparation of pulp for artificial silk.*—Experiments on the purification of bamboo pulp, to render it suitable for artificial silk manufacture, were continued throughout the year. It was found possible to prepare a pulp with 96 per cent. alpha cellulose and 0·2 per cent. to 0·3 per cent. ash content. Trials of the method which gave these results will be carried out on a semi-commercial scale next year.

(*b*) *Chemical analyses of raw materials.*—Determinations of cellulose, lignin, pentosans, ash, caustic soda solubility, etc., were made with :—

(1) *Saccharum spontaneum.*

(2) *Pinus longifolia.*

(3) *Dendrocalamus strictus* bamboos from Bihar and Orissa (analyses still in progress).

(*c*) *Tests on savannah grasses from Assam.*—The following eight grasses* from the Goalpara division of Assam were tested as to their suitability for pulp and paper making :—

(1) *madhauli*, (2) *baranga*, (3) *ulu*, (4) *bata*, (5) *majra*, (6) *baranga-tanga*, (7) *malsa* and (8) *khagra.*

The grasses were found to possess fairly long fibres (3-4 mm.), and the consumption of chemicals for digestion and bleaching was also found to be within economic limits ; but the percentage yields of pulps were very low, varying from 22 to 26·5. The grasses, therefore, though suitable for paper-making, cannot economically be used for the purpose, unless available at very low prices.

(*d*) *Tests on Saccharum spontaneum* (*kans*).—Preliminary tests to determine the optimum conditions of digestion on a large scale, so as to obtain clean and easy bleaching pulp, were carried out on this material.

(*e*) *Straw-boards from sabai grass* (*Ischoemum angustifolium*).—Experiments on the preparation of fairly non-absorbent straw boards from the grass were carried out at the request of Messrs The Straw Board Manufacturing Co., Saharanpur. Satisfactory samples were prepared and supplied to the firm for trial and opinion.

(*f*) *Lantana wood.*—Tests were carried out on this wood at the request of the Madras Forest Department. The yield of pulp from the material was satisfactory, but the fibre length was found to be very short. The pulp from the wood can at best be used as a filler in the manufacture of papers from bamboo pulp, etc.

(*g*) *Tests on miscellaneous materials.*—(i) *Diospyros melanoxylon* leaves were tested for the production of papers for use in the manufacture of *beedies* (country cigarettes).

(ii) *Vetiveria zizanioides* (*khar* grass) was tested for its paper-making qualities. The yield of pulp from it was found to be very poor.

(iii) Whole linseed straw was tested for the production of straw-boards. The results obtained were very satisfactory.

* The correct scientific names of the grasses are not yet known.

(*h*) *Boiler feed water.*—Routine analytical tests in connection with the softening of the boiler feed water were carried out as and when required.

3. *Technical Information and Advice.*

(*a*) The Paper Mill at Jagadhri was visited in September 1933 in order to report on the capacity and the condition of the existing plant to a private syndicate interested in undertaking the operation of the mill.

(*b*) Suggestions and advice were given to Messrs The Upper India Couper Paper Mills, Lucknow, with regard to new plant and to changes in the existing plant, considered necessary to increase the efficiency and output of the Mill.

(*c*) Correspondence was carried on with private individuals, commercial firms and Government departments in connection with 22 technical inquiries referred to the Section.

4. *Bamboo Pulp Projects.*

Although no new bamboo projects materialised during the year under report, bamboo has been finding increasing use in existing mills. Messrs The Titaghur Paper Mills are using over 15,000 tons of bamboo per annum, which is partly responsible for their reduction in the consumption of *sabai* grass. Large quantities of this grass are thus available now, particularly from the Western Circle, U. P., for the use of the mills at Lucknow and Jagadhri. It is understood that Messrs The India Paper Pulp Co. have installed a new type of chipping and disintegrating plant for bamboo. The performance of this plant will be watched with interest.

Mechanical Sub-Section.

This auxiliary Sub-Section functioned most satisfactorily throughout the year under the guidance of Mr. Ram Das Tandan, the Mechanical Engineer and B. B. L. Saksena his Electrical Assistant.

One laboratory kiln on the principal of internal circulation, and two laboratory kilns with constant humidity chambers, were constructed for the Seasoning Section. Several modifications were carried out on the disintegrator installed 2 years ago in the Paper Pulp Section with a view to adapting this machine for disintegrating bamboos. A shaking machine was also made and installed in the Wood Preservation laboratory.

The steam boilers, the Institute lorries, the fire extinguishing appliances and other plant were kept in proper working order throughout the

year. The 150 K. W. direct current generating sets and all electric motors, both big and small, as well as the electric ovens installed in the various workshops and laboratories of the Institute, were maintained in good order.

The total number of mechanical and electrical jobs carried out in the mechanical repair workshops during the year amounted to 450. These included the overhauling and repairing of machines and lawn mowers, as well as the repairing and re-winding of electric motors, starters and electric ovens.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A. Drugs :—

i. *Actinodaphne hookeri*, Meissn.
ii. *Artemisias.*
iii. *Bombax malabaricum*, DC.
iv. *Derris* spp.
v. *Spatholobus roxburghii*, Bth.
vi. *Tephrosia candida*, DC.
vii. *Strychnos nux-vomica*, Linn.
viii. *Vitex negundo*, Linn.

B. Essential oils :—

Santalum album, Linn.

C. Oils and Fats :—

i. *Cinnamomum camphora*, Linn.
ii. *Litsæa zeylanica*, Nees.
iii. *Melia azedarach*, Linn.
iv. *Quercus incana*, Roxb., *Q. dilatata*, Lindl., and *Q. ilex*, Linn.

2. Study of forest soils.
3. Miscellaneous enquiries.

I. A.—Drugs.

(i) *Actinodaphne hookeri*, Meissn.—It was reported in 1931-32 that an alkaloid *actinodaphnine* had been isolated from the bark of this tree and that a preliminary chemical study had been made. Further work on the chemical constitution was carried out in collaboration with Dr. Schlittler of the Oxford University. The alkaloid has now been found to be a secondary base of the formula $C_{18}H_{17}N\,O_4$ and closely related to *laurotetanine*, *dicentrine* and other *aporphine* bases. That it contains a phenanthrene nucleus has been shown by its oxidation and methylation products, and the position of the four oxygen atoms in the molecule has

been indicated by the detection of a methoxyl, hydroxyl and a methylene-dioxy groupings. These have led to our assigning to *actinodaphnine* an aporphine structure, but there still remains uncertainty regarding the relative position of the hydroxyl and the methoxyl groupings in the molecule.

(ii) *Indian Artemisias.*—During the last few years attention had been concentrated on *Artemisias* from Kashmir and Kurram valleys but this year the investigation has been extended to *Artemisias* found in Tehri-Garhwal, Kagan, Kulu, Upper Bashahar and Malakand, with a hope of discovering the santonine bearing species. This hope has not been realised as all the samples, from the above localities, were found to be santonine free.

It was reported last year that attempts to grow, in Dehra Dun, *Artemisia maritima* from the seeds obtained from Kurram valley had been successful and that the santonine content in the second year of its growth was almost as high as in plants growing in their natural habitat. Similar attempts have now been made on Kashmir *Artemisias* (*A. brevifolia*) and the results obtained are recorded below :—

Time of collection.	Santonine percentage.	Remarks.
4th week of August 1933 . . .	0·60	leaves only.
4th week of October 1933 . . .	0·66	
4th week of October 1933 . . .	0·69	buds only.
1st week of December 1933 . .	0·91	leaves and buds.
1st week of January 1934 . . .	0·78	
1st week of February 1934 . .	0·12	
1st week of March 1934 . . .	0·66	fresh leaves.

The data given above indicate that in the first year of its growth, in Dehra Dun, in the plants raised from Kashmir *Artemisia* seeds, the buds formed rather late (October) and they matured in November-December, shifting thereby the period of maximum santonine content to early in December. In its natural habitat, on the other hand, August is the period of maximum santonine content, the buds appearing in May. (Simonsen, *Jour. Ind. and Labour* 1921, 1, 539.) It is, however, possible that when the plants get acclimatized, the period of maturity might shift back again to June-July, that is prior to the monsoon, as in the case of the Kurram *Artemisias.*

(iii) *Bombax malabaricum*, DC. *vern. Semul.*—Tap roots of the young plant known as *musli*, according to books on the Indian system of medicine, enjoy great reputation as a powerful aphrodisiac and tonic, but it appears that its medicinal properties have been exaggerated. Chemical examination showed it to contain moisture, 7·5; ash, 2·1; proteids, 1·2; fatty matter, 0·9; phosphatide, 0·3; colouring matter, 0·5; tannins, 0·4; non-tans, 0·1; sugars, 8·2; starch, 71·2; pectus matter, 6·0 and cellulose 2·0 per cent. No glucoside or alkaloid was detected. Analyses of tubers of different ages showed that the proportion of the above constituents varied with the age of the roots. In younger ones sugar, starch and pectus matter predominated whereas in the maturer ones, tannin and cellulose.

None of the above constituents, excepting the phosphatide, was considered the likely substance responsible for the reputed medicinal properties. The phosphatide, which is associated with fatty matter, was expected to be lecithin, a common constituent of many plant materials; but a detailed examination showed it to be a cephalin like substance, practically insoluble in absolute alcohol and acetone but freely soluble in dry ether. This observation is interesting in so far as cephalin is not regarded as a common constituent of plant tubers. Literature records only one case of cephalin having been discovered in soya beans.

The fatty matter is an orange coloured, thick viscous oil of the following constants—Refractive Index, at 20°C, 1·4747; Iodine Value, 63·5 and Saponification Value, 210·4. It appeared to have the usual constituent acids. Search was also made for vitamines A, D and E but without success.

The mucilage appears to be a silico-phosphoric ester of manno-galactan. The occurrence of phosphoric and silicic ester of a polysaccharide in nature is not uncommon. For example, it has been reported that the mucilage of the seeds of fenugreek (*Triginella fœnum graccum*, Linn.) is a salt of silico phosphoric ester of manno-galactan. It is possible that the mucilage, besides the phosphatide, is to some extent responsible for some of the effects of the drug since it is reported by some medical practitioners "to be a good demulcent tonic possessing some soothing action on the mucous membrane of the genito urinary tract but nothing beyond."

(iv) *Derris* spp.—It was reported last year that roots and twigs of *Derris uliginosa* (collected in Sundarbans in November 1932) were, unlike those of *D. elliptica*, very poor in ether solubles. The roots did not yield any weighable quantity of rotenone although the ether extract gave the characteristic colour reaction. (Jones and Smith, *Ind. and Eng. Chem. An. Ed.* V, 75). Another sample of roots collected from the same

locality in June 1933 was also very poor in ether soluble extractives, giving the colour test for rotenone but from which no rotenone could be isolated. Ether extract of twigs, in either case, gave no reaction for rotenone. A further sample from the same locality, collected in October 1933, also failed to yield any rotenone. From this it might be concluded that there is no seasonal variation of the rotenone content or allied substances (ether extractives) in *D. uliginosa*.

A sample collected in October 1933 from Chittagong division was analysed but was not found to be superior to the samples from Sundarbans, results for which are recorded above. In this case also no rotenone could be isolated even though a distinct colour reaction was obtained. Attempts to isolate other insecticidal bodies, allied to rotenone, such as deguelin and tephrosin were unsuccessful. These results lead to the conclusion that *D. uliginosa* cannot be considered as a good insecticide since it contains practically no rotenone, deguelin, tephrosin or other allied bodies and whatever feeble insecticidal properties it is supposed to possess are possibly due to the resinous bodies present in it.

Derris elliptica.—Only one sample has so far been examined and this was collected in June 1933, from Dibrugarh, Assam. It yielded 2·5 per cent. of ether solubles of which 0·8 per cent. was rotenone. This sample although of poor quality, when compared to Malayan *Derris* of 7-8 per cent. rotenone content, is the first sample of rotenone bearing *Derris* of purely Indian origin that we have examined in this Institute, and it is hoped that with cultivation and care it might be possible to raise better quality roots. Search is being made for *D. elliptica* in other parts of Assam and samples are being awaited.

Derris robusta, Bth.—Roots and twigs were obtained from Kamrup division, Assam, in October 1933. The analyses showed it to contain 4·7 per cent. of ether solubles of which 1·2 per cent. was a crystalline substance, which on purification was obtained in stout prismatic needles m.p. 195°-196°C. It gave no colour tests for rotenone. Complete identification of this substance has not yet been possible but it appears to be tephrosin, a substance allied to rotenone and is likewise poisonous to insects. From the resinous matter another light yellow crystalline substance was obtained which on purification melted at 171°-172° and which appears akin to deguelin (m.p. 174°-175°), another insecticide. No rotenone could be isolated, nor was any colour reaction obtained from the ether extracts. The nature of these crystalline substances is being investigated further.

(v) *Spatholobus roxburghii*, Bth.—Jones (J. A. C. S. *55*, 1737) reported that about 1 per cent. of rotenone is present in the root bark of the samples obtained from Burma. The samples of *Spatholobus* collected locally in June and September were examined, but neither the root bark

nor the woody portion showed any presence of rotenone or allied substances.

(vi) *Tephrosia candida*, DC.—It is an allied species to *Caracca verginiana* found in U. S. America, which has been reported to contain rotenone, deguelin and tephrosin. Roots of *T. candida* growing in the Institute were examined and although 0·9 per cent. of ether extract, containing 0·2 per cent. of a crystalline substance m.p. 230°C was isolated, no test for rotenone was obtained. It is intended to examine a few more *Tephrosia* spp. before rejecting it as unfit for insecticidal purposes.

(vii) *Strychnos nux-vomica*, Linn.—It was reported last year that *nux-vomica* seeds are frequently adulterated with spurious seeds of *S. nux-blanda* which do not contain any strychnine but which resemble the genuine strychnos seeds in appearance when properly made up. Chemical assay of the seeds is a lengthy procedure and the saving of time is an important factor especially when large quantities of material have to be purchased. A single chemical assay is hardly of any value as the *nux-blanda* seeds might not be uniformly mixed in all the bags of the same consignment. A search, therefore, was made for a quick method of distinguishing the two species. For this purpose the seeds were examined under ultra violet light from a mercury vapour lamp, fitted with Wood's filter. The *nux-vomica* seeds show a dull brown fluorescence and the *nux-blanda* seeds a slightly lighter shade. This distinction is not of much significance but when split seeds were examined, both showed a brilliant fluorescence: *nux-vomica* giving bluish and *nux-blanda* pink. This distinction becomes greatly marked and the depth of colours are clearly brought out when viewed under mixed light namely the ultra violet light and the ordinary electric light. It has been possible in this way to distinguish the two species of seeds.

(viii) *Vitex negundo*, Linn. vern. *nirgundi*.—Is a herb, common throughout India and well known in the Hindu system of medicine. The leaves are reported to be useful in sprains and rheumatism and the roots as tonic, febrifuge and expectorant (*Pharm. Ind.* Vol. III, p. 72). Chemical literature records nothing about the constituents of this plant and, therefore, its investigation was taken up. Air-dried powdered leaves (moisture 13 per cent.) gave 8·9 per cent. to petrol; 1·4 per cent. to ether; 0·6 per cent. to chloroform; 2·6 per cent. to ethyl acetate and 8·9 per cent. to alcohol. About 0·03 per cent. of an unidentified alkaloid has also been obtained.

The alcoholic extract, on standing, deposited a white crystalline substance m.p. 196°-98°C which was found to be a polyhydric alcohol. Further treatment of the alcoholic extract gave two acids one melting at 220°C, crystalline needles and the other melting at 184°-85°C, crystalline

needles giving greenish blue colour with ferric chloride and deep yellow colour with alkalis. A glucosidal substance has also been isolated and this on hydrolysis with acids yields the crystalline substance m.p. 220°-21°C. Further work on these products is in progress. The glucoside and the acidic substance described above appear to be the active constituents of the leaves and might be responsible for their therapeutic value.

I. B.—*Essential oils.*

Santalum album, Linn.—For commercial classification it is sorted into 18 different grades based on size, quality, physical appearance, etc., but without any reference to their oil content. The oil content, however, is an important consideration and no reliable information is available on this subject especially for the Madras and Coorg sandal wood and hence the present investigation, at the suggestion of the Chief Conservator of Forests, Madras.

For purposes of sampling a single tree was selected in each locality and from its different parts different commercial grades of wood, namely *ghatbadla*, *cheria*, roots, *basola bukni*, etc., were extracted in accordance with the usual practice and the oil content determined. The results obtained are tabulated below. From this it will be noticed that commercial classification based on weight and physical appearance has no intimate connection with the oil content and, speaking generally, the roots contain a much higher amount of oil than the stems and branches. It will also be noticed that *ainbagar* and *cheria* which consist of thinner billets from stems and branches, are often richer in oil content than the thicker parts of the stem represented by *ghatbadla* and *bagardad*. It is, therefore, obvious that when the wood is to be used for purposes of distillation of the oil, the present system of classification has no significance.

Oil content of different grades of Sandal wood from Coorg and Madras.

Commercial classification of sandal wood.	Description.	Locality.					
		Coorg.	Salem.	Kollegal.	Vellore.	Tinnevelly.	Mangalore.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1. Ghatbadla .	Billets with knots and cracks and hollows weighing not less than 16 lbs.	6·6	6·6	6·1	5·3	3·4	5·4
2. Bagardad .	Solid pieces without special reference to weight and number.	6·3	..	..	..	..	..

Oil content of different grades of Sandal wood from Coorg and Madras—(contd.)

Commercial classification of sandal wood.	Description.	Locality.					
		Coorg.	Salem.	Kollegal.	Vellore.	Tinnevelly.	Mangalore.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
3. Roots—							
Class I .	Pieces not less than 15 lbs.	8·5	5·9	5·7	6·5	5·0	7·4
Class II .	Pieces not less than 5 lbs.	9·4					
Class III .	Small lateral roots less than 5 lbs. *	10·1					
4. Jujpokal Class I.	Hollow pieces of not less than 7 lbs.	7·3	..	..	..	..	..
5. Jujpokal Class II.	Hollow pieces of not less than 3 lbs.	6·5	..	..	..	..	..
6. Ainbagar .	Solid cracked and hollow pieces of not less than 1 lb.	8·0	..	..	..	..	..
7. Cheria .	Pieces and chips of heart wood not less than ¼ lb.	6·1	7·1	7·1	6·5	..	5·4
8. Ainchilta .	Pieces and chips of heart wood.	6·6	..	..	..	..	..
9. Basola Bukni.	Small mixed heart and sap wood chips.	4·9	4·8	5·2	2·8	2·4	2·1

NOTE.—The oil per cent. has been calculated on wood containing no moisture.
* Roots were not classified.

Sandal wood, as is generally known, is frequently adulterated with other woods which resemble it in appearance but contain no pleasant smelling essential oil in them. They are, however, capable of imbibing the odour and when left in contact with the genuine sandal wood, they begin to give out the scent. In this way cheaper and spurious woods are sold as genuine sandal wood, and it is a matter of great difficulty for a layman to make out a suitable distinction between the two. Attempt was, therefore, made to discover some simple and easy physical or chemical test for making this distinction. For this purpose, effects of various chemicals on sandal wood and also on its alcoholic extracts were tried and compared with those obtained, on similar treatment, from *Santalum spicatum*, *Mansonia gagei*, *Ximenia americana* and *Erythroxylon monogynum*, which resemble sandal wood in appearance and are often used as adulterants. For the above purpose, series of tests such as the following—determination of the hydrogen ion concentration of the aqueous extract of the ash, treatment of the alcoholic extract with acids, metallic salts, etc., were carried out and in this way it was found possible to differentiate the sandal wood from other species but a very much larger number of samples will have to be examined before a definite and an exact test is established. The great drawback of the present procedure is that it is far more elaborate than what would be desirable as a rapid field test.

I. C.—*Oils and Fats.*

(i) *Litsaca zeylanica*, Nees.—It was reported last year that the fat from the seeds of *Actinodaphne hookeri* contained about 96 per cent. of trilaurin. It was interesting to extend this study and make a search for other indigenous sources of lauric acid and for this purpose other species namely *Litsaea zeylanica* and *Cinnamomum camphora* allied to *Actinodaphne hookeri* were investigated.

The seeds of *Litsaea zeylanica* yielded 37 per cent. of endocarp and 63 per cent. of kernels and the latter on hot expression gave 33·5 per cent. of a pale yellow fat, crystallising in star shaped needles. Additional 24·5 per cent. of the fat was obtained on solvent extraction. The expressed fat had an iodine value 15·2 and saponification value 258·5. On crystallising from absolute alcohol it gave 70 per cent. of trilaurin.

(ii) *Cinnamomum camphora*, Linn. seeds gave 90 per cent. of kernels, which under hydraulic pressure yielded 39 per cent. of a pale yellow oil, setting hard on cooling and a further 26·5 per cent. was obtained on solvent extraction. The fat had iodine value 4, and appeared to contain trilaurin but in amounts much less than in *Litsaea zeylanica* seeds. Further work on this fat is in progress.

(iii) *Melia azedarach*, Linn. Persian Lilac.—In view of the reported medicinal value of the leaves, fruit, etc. of this tree and its similarity to the famous *neem* tree (*Azadirachta indica*) a chemical analysis of the kernel oil was undertaken. This investigation is in progress but the data collected up to date is given below :—

Moisture in the kernels	8·2 per cent.
Oil in the kernels by expression	13·5 „
Total oil in kernels	33·0
Iodine value (Hanus)	135·8
Refractive Index at 20°C	1·4688

(iv) Indian acorns (*Quercus incana*, Roxb., *Q. dilatata*, Lindl. and *Q. ilex*, Linn.).

Quercus grow all over the hills in Northern India and yield acorns in great abundance. At present, these find no commercial application because of the low content of oil in kernels and the poor quality of the tanning material in the " acorn cups " (Valonia of trade). In view of the absence of any chemical data on the oils, it was considered desirable to take up their investigation. Of about thirty species which occur in India, *Q. incana* (vern. *Banj*) is probably the best known and the oil from its acorns was therefore investigated in detail.

The kernels (81 per cent.) contained 16 per cent. of oil of the following constants :—

——	*Q. incana.*	*Q. dilatata.*	*Q. ilex.*
Consistency	thin	thin	thin
Colour	yellow	orange	orange
Specific gravity at 25°C . . .	0·9081	0·9084	0·9079
Refractive Index at 30°C. . .	1·4576	1·4588	1·4576
Saponification value . . .	192·2	188·4	189·9
Iodine value (Hanus) . . .	81·5	90·3	83·0
Acetyl value	14·8	21·1	17·4
Hehner value	96·1	88·2	94·9
Acid value	13·0	22·2	8·5
Unsaponifiable matter . . .	0·8%	2·3%	0·9%

Chemical constants of the mixed fatty acids of incana oil—

Mean molecular weight	285·2
Iodine value (Hanus)	80·8
Saturated acids	18·0
Unsaturated acids	82·0

Further examination of the acids indicated the oil to be a mixture of the glycerides of palmitic, lignoceric and oleic acids.

It has been reported by some workers that " dried acorns make a useful feeding material on account of their high starch content and digestible fibre. Drying the acorns is said to remove a great deal of the astringency which make fresh acorns impalatable and sometimes injurious to stock. At the same time they contain no substance injurious to poultry. Their food value is equivalent to a mixture of oats and maize. They may replace grain in poultry feed if their slight deficiency in protein is made up ".

The analyses carried out in this Institute gave the following results for *Q. incana* kernels :—

> Moisture, 12·2 ; oil, 16 ; ash, 1·4 ; proteins, 3·0 ; cellulose, 1·4 ; tannins, 4·2 ; carbohydrate (by difference), 61·8 and 59·5 (by direct determination). No sulphur was detected.

The acorn cups in some of the Greek and Smyrna oaks are said to yield a high percentage (68 per cent.) of tannin (*Bull. Imp. Inst. 10*, 645) and they form a valuable source of commercial tannins. The cups

of the Indian acorns were, therefore, examined for this purpose and the following results were obtained :—

— —	*Q. incana.*	*Q. dilatata.*	*Q. ilex.*
Moisture	12·4	11·4	11·8
Ash	3·0	2·4	2·6
Total solids (water extracts) . .	13·3	13·4	12·0
Tannins.	8·7	..	8·0

2. *Soils.*

Examination of the laterite soils from Assam and Chittagong has been made and also a large number of soils from experimental plots in the Institute have been examined for their moisture content.

3. *Miscellaneous enquiries.*

A large number of analyses of various substances were undertaken on behalf of the officers of the Institute and forest officers. Particular mention may be made of the following :—

Casein cements, glues, Eucalyptus and Palmarosa grass oils, Cinnamon bark, Katha, disinfectants, etc.

APPENDIX I.

PUBLICATIONS OF 1933-34.

Serial No.	Title of Publication.	Author.	Date of issue.
	FOREST RECORDS.		
1	Entomological Investigations on the Spike Disease of Sandal (8) Carabidae.	H. E. Andrewes .	October 1933.
2	Entomological Investigations on the Spike Disease of Sandal (9) Neuroptera.	Nathan Banks .	July 1933.
3	Entomological Investigations on the Spike Disease of Sandal (10) Melasidae and Elateridae.	E. Fleutiaux . .	August 1933.
4	Entomological Investigations on the Spike Disease of Sandal (11) Fulgoridae.	N. C. Chatterjee .	August 1933.
5	Entomological Investigations on the Spike Disease of Sandal (12) The Life History and Morphology of *Eurybrachys tomentosa*, Fabr. (Fulgoridae).	N. C. Chatterjee .	January 1934.
6	Entomological Investigations on the Spike Disease of Sandal (13) Membracidae and Cercopidae (Homopt.)—Supplementary Data.	N. C. Chatterjee and M. Bose.	December 1933.
7	Entomological Investigations on the Spike Disease of Sandal (14) Jassidae (Homopt.).	H. S. Pruthi . .	February 1934.
8	Entomological Investigations on the Spike Disease of Sandal (15) Cicindelidae (Col.) and Supplementary Data on Neuroptera and Elateridae (Col.).	N. C. Chatterjee .	February 1934.
9	Entomological Investigations on the Spike Disease of Sandal (16) Coccinellidae (Col.).	R. Korschefsky .	February 1934.
10	Entomological Investigations on the Spike Disease of Sandal (17) Coccinellidae (Col.), Supplementary Data.	N. C. Chatterjee and M. Bose.	February 1934.
11	Entomological Investigations on the Spike Disease of Sandal (18) Fulgoridae (Homopt.).	N. C. Chatterjee and M. Bose.	March 1934.
12	Entomological Investigations on the Spike Disease of Sandal (19) On the Life History and Morphology of *Pelalocephala nigrilinea* (Jassidae, Homopt).	N. C. Chatterjee .	April 1934.
13	Entomological Investigations on the Spike Disease of Sandal (20) Studies on Insect Transmission.	Cedric Dover and M. Appanna.	May 1934.
14	Entomological Investigations on the Spike Disease of Sandal (21) Thysanoptera.	T. V. Ramakrishna Ayyar.	June 1934.
15	Entomological Investigations on the Spike Disease of Sandal (22) Formicidae (Hymen.).	Durgadas Mukerji .	May 1934.
16	A Stand Table for Sal (*Shorea robusta*) Evenaged High Forest.	I. D. Mahendru .	November 1933.
17	New Thysanoptera from India	Dudley Moulton .	November 1933.
18	Multiple Yield Tables for Deodar . . .	H. G. Champion and I. D. Mahendru.	November 1933.
19	Investigations on the Infestation of *Peridermium himalayense* on *Pinus longifolia*, Part II.	K. D. Bagchee .	November 1933.
20	Regeneration and Management of Sal . .	H. G. Champion .	November 1933.
21	The Physical and Mechanical Properties of Woods Grown in India, Third Interim Report on Project No. 1.	V. D. Limaye. .	November 1933.
22	Immature Stages of Indian Coleoptera (14)—(Curculionidae).	J. C. M. Gardner .	May 1934.
23	On the Biology of Mantidae	R. N. Mathur. .	May 1934.

APPENDIX I—*contd.*

Serial No.	Title of Publication.	Author.	Date of issue.
	FOREST BULLETINS.		
24	Testing and Selection of Commercial Wood Preservatives.	S. Kamesam . .	December 1933.
25	Measurement of Standing Sample Trees . .	H. G. Champion .	April 1934.
26	Provisional Yield Table for *Quercus incana*, Roxb. (*Banj* or *Ban* Oak).	H. G. Champion and I. D. Mahendru.	July 1934.
27	Identification of the Commercial Timbers of the Punjab.	K. A. Chowdhury .	August 1934.
	OTHER PUBLICATIONS.		
28	Guide to the Forest Research Institute, Dehra Dun.	....	October 1933.
29	Progress Report of Forest Research in India, 1932-33, Part I.—The Forest Research Institute.	....	October 1933.
30	Progress Report of Forest Research in India, 1932-33, Part II.—Provincial Reports.	....	January 1934.
31	Tables for use with Brandis Hypsometer for Measuring the Height of Trees.	F. B. Manson and H. H. Haines.	November 1933.
32	Forty Trees Common in India	R. N. Parker . .	November 1933.
33	Progress Report of the Forest College, Dehra Dun, for 1932-33.	....	February 1934.
34	Annual Return of Statistics relating to Forest Administration in British India, for 1932-33.	....	July 1934.
35	Classified List of Officers of the Indian and Provincial Forest Services, and of the Forest Engineering Service in India and Burma, on 1st July 1933.	....	December 1933.

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS.

Silviculture.

Champion, H. G. . . European Silvicultural Research, Parts VI-IX. (*Indian Forester*, April, June, July, August, 1933.)

Champion, H. G. . . The meaning of crop diameter for the use of alignment chart (*Indian Forester*, December 1933).

Champion, H. G. and Mahendru, I. D. . The Selection of Radii for Stump Analysis (*Indian Forester*, September 1933).

Champion, H. G. . . Underplanting in Teak Plantations (*Indian Forester*, May 1933).

Champion, H. G. . . The Effect of Thinning out Multiple Shoots on Young Root Stocks (*Indian Forester*, January 1934).

Champion, H. G. . . Seed Crop and Fertility of *Anogeissus latifolia* (*Indian Forester*, February 1934).

Gorrie, R. M. . . . Importance of the Origin of Seed used in Forestry (*Indian Forester*, April 1933).

Gorrie, R. M. . . . Plantations *versus* Retrenchment (*Indian Forester*, September 1933).

Gorrie, R. M. . . . Recent Studies on Tree Roots (*Indian Forester*, March 1934).

Botany.

Parker, R. N. . .	Leguminosae and Root Nodules (*Indian Forester*, April 1933).
Parkinson, C. E. .	A New Burmese Bamboo (*Indian Forester*, November 1933).
Parkinson, C. E. .	Indian Species of Xylocarpus (*Indian Forester*, February 1934).
Parkinson, C. E. and Raizada, M. B.	Indian Wendlandias (*Indian Forester*, June 1933).

Entomology.

Beeson, C. F. C. .	Liability of solid bamboo lance staves to attack by borers (*Indian Forester*, November 1933).
Beeson, C. F. C. .	Control Measures for Termites (*Indian Forester*, January 1934).
Beeson, C. F. C. .	Prickly Pear and Cochineal Insects (*Indian Forester*, March 1934).
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APPENDIX III.

Statement showing Officers in charge of Branches and Sections during the year 1933-34.

Branch.	Officer-in-Charge.	Section.	Officer-in-Charge.	From	To
Silviculture .	Mr. H. G. Champion, Silviculturist.	..	..	1-4-1933	31-3-1934
		Experimental .	Mr. P. N. Deogun	1-4-1933	31-3-1934
		Statistical .	Mr. I. D. Mahendru	1-4-1933	30-4-1933
	..		Mr. M. A. Kakazai	1-5-1933	31-3-1934
Botany . .	Mr. C. E. Parkinson, Forest Botanist.	..	..	1-4-1933	31-3-1934
		Mycology .	Dr. K. D. Bagchee	1-4-1933	31-3-1934
Economy .	Capt. H. Trotter, Forest Economist.	..	..	1-4-1933	31-3-1934
		Minor Forest Products.	Capt. H. Trotter	1-4-1933	31-3-1934
		Timber Testing.	(Mr. V. D. Limaye)	1-4-1933	20-10-1933
			Mr. L. N. Seaman	21-10-1933	31-3-1934
		Wood Preservation.	Mr. S. Kamesam .	1-4-1933	4-8-1933
			(Capt. H. Trotter)	5-8-1933	15-8-1933
			Mr. S. Kamesam	16-8-1933	15-11-1933
			(Capt. H. Trotter)	16-11-1933	25-2-1934
			Mr. S. Kamesam .	26-2-1934	31-3-1934
		Seasoning .	(Mr. A. Rahman)	1-4-1933	24-4-1933
			Dr. S. N. Kapur .	25-4-1933	11-1-1934
			(Mr. A. Rahman)	12-1-1934	27-1-1934
			Dr. S. N. Kapur .	28-1-1934	31-3-1934
		Paper Pulp .	Mr. M. P. Bhargava	1-4-1933	31-3-1934
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1933	31-3-1934
		Wood Workshop	Mr. W. Nagle .	1-4-1933	2-3-1934
			(Capt. H. Trotter)	3-3-1934	31-3-1934
Entomology .	Dr. C. F. C. Beeson, Forest Entomologist.	..	..	1-4-1933	31-3-1934
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1933	31-3-1934
Biochemist .	Dr. S. Krishna, Biochemist.	..	..	1-4-1933	4-3-1934
	(Mr. T. P. Ghose) .	..	..	5-3-1934	26-3-1934
	Dr. S. Krishna .	..	..	27-3-1934	31-3-1934

APPENDIX IV.

ANNUAL FORM No. 24.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure of the Branches during 1933-34.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
REVENUE.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
V.—Miscellaneous—							
(*b*) Other sources . .	2,304	227	14	22	2,499	..	5,066
(*d*) Sale of timber and furniture from Seasoning and Wood Workshop Depot.	..	..	..	..	699	..	699
Total Revenue .	2,304	227	14	22	3,198	..	5,765
EXPENDITURE.							
A.—Conservancy, Maintenance and Regeneration—							
C.—Live stock, Stores, tools, and plant—							
C. 1.—Purchase of stores, tools, and plant.	902	616	366	289	2,261	4	4,438
C. 2.—Communications and Buildings, New Work—							
(*a*) Roads and bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other works . .	..	..	..	..	..	..	..
C. 3.—Communications and Buildings, Repairs and Maintenance—							
(*a*) Roads and bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other charges . .	505	..	..	..	..	..	505
C. 1.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	7,523	1,223	3,375	2,352	1,963	421	16,857
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	6,247	..	6,247
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	287	11,062	2,540	13,889
(4) Other charges . .	503	2,929	1,747	1,532	14,983	204	21,898
Total A.—Conservancy, Maintenance and Regeneration.	9,433	4,768	5,488	4,460	36,516	3,169	63,834

APPENDIX IV—*contd.*

ANNUAL FORM No. 24—*contd.*

FOREST RESEARCH INSTITUTE—*contd.*

Summary of Revenue and Expenditure of the Branches during 1933-34—contd.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
EXPENDITURE—*contd.*	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
B.—Establishments—							
I.—Pay of Officers—							
Non-voted—							
(*a*) Conservators . .	..	..	..	..	..	..	..
(*b*) Superior officers .	13,248	15,196	..	30,315	16,863	..	75,622
Voted— Superior officers . .	237	15,207	29,122	15,189	91,778	21,354	1,72,977
II.—Pay of Establishment—							
Pay of establishments .	26,166	20,700	10,610	25,707	95,678	5,572	1,84,733
III.—Allowances—							
Cost of passage (Central) —							
Non-voted . . .	..	..	..	..	..	..	..
(*b*) House-rent and other allowances—							
Non-voted . . .	..	..	..	..	..	..	..
Voted	505	..	..	..	..	..	505
Travelling allowances—							
(*c*) Conservators, Non-voted	..	..	..	..	..	..	..
(*d*) Superior officers—							
Non-voted . . .	527	2,338	..	2,015	429	..	5,339
Voted	..	1,155	1,617	1,222	7,241	651	11,886
(*e*) Subordinate forest and depot establishments.	..	128	110	750	..	..	988
(*f*) Office establishments .	..	1,000	333	1,422	320	..	3,135
Cost of passage to America of officers for training, etc.	..	..	..	..	..	..	..
IV.—Contingencies—							
(*a*) Stationery . . .	182	116	30	..	..	..	328
(*b*) Carriage of records and tents.	..	480	218	448	13	..	1,150
(*c*) Rents, rates and taxes	922	181	420	..	49	..	1,572

APPENDIX IV—*concld.*

ANNUAL FORM No. 24—*concld.*

FOREST RESEARCH INSTITUTE—*concld.*

Summary of Revenue and Expenditure of the Branches during 1933-34—concld.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*concld.*							
(*d*) Pay of menials . .	..	..	..	..	..	..	..
(*e*) Official postage . .	363	425	672	306	487	51	2,804
(*f*) Sundries . . .	19,032	1,163	898	1,357	1,242	868	25,460
(*g*) Clothing and uniform .	217	46	26	35	332	28	684
(*h*) Telephone . . .	629	266	272	238	1,446	52	2,903
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-voted).	600	600	..	..	600	..	1,800
Payment on account of medical treatment.	..	..	..	..	..	..	..
Total B.—Establishments .	64,328	59,151	44,328	79,034	2,16,478	28,576	4,91,895
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	73,761	63,919	49,816	83,494	2,52,994	31,745	5,55,729
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	..	..	..	1,785	505	..	2,290
Surplus or deficit . .	—71,457	—63,692	—49,802	—85,257	—2,50,301	—31,745	—5,52,254

NOTE.—The figures given in this statement have been prepared in the President's Office and are based on the Summary of Revenue and Expenditure for March 1934 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items.

C. G. TREVOR,

President,

Forest Research Institute and College.

MGIPC—S6—III-2-62—8 9-34—340.

11 MAR 1935

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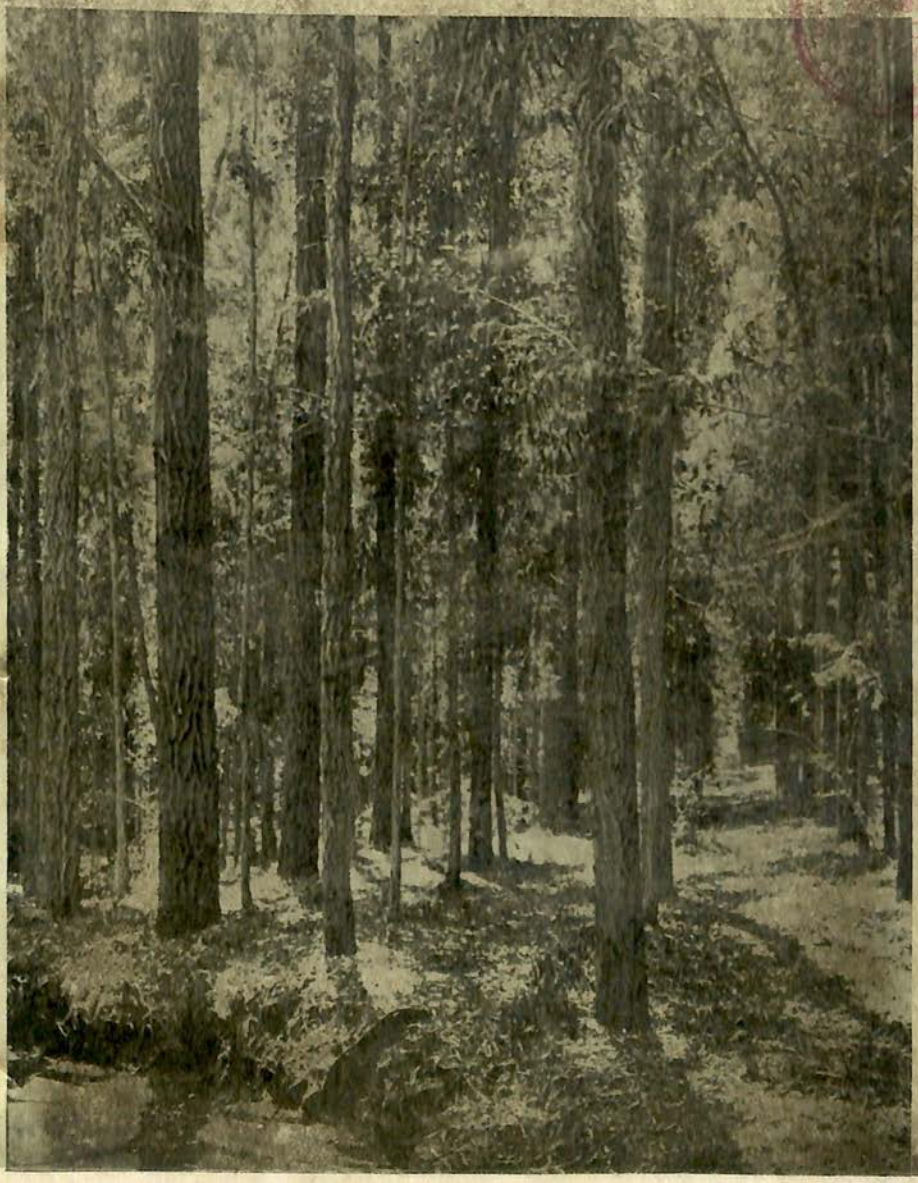

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FOREST RESEARCH IN INDIA, 1933-34.

PART II.—PROVINCIAL REPORTS.

CHAPTER I.

GENERAL.

A considerable volume of research has again been undertaken mostly in co-operation with the Forest Research Institute chiefly in connection with the various silvicultural problems of so much importance to scientific forestry in India. Silvicultural research in most provinces is now firmly established on a sure foundation in spite of the financial difficulties which have faced all administrations. It must be recognised that the future of forest finance is largely dependent on improved silvicultural technique in the regeneration and treatment of forest crops; that greater intensity of management necessarily involves greater attention to the silvicultural needs of the species concerned and to problems of insect and fungoid attacks. The importance of race and habit of growth in the selection of seed for artificial reproduction is only just being realised and the investigation of forest soils in India has hardly been commenced. Without knowledge concerning growth and yield the forester is largely working in the dark and it is the object of research to supply such knowledge, to elucidate the causes of disease and to suggest the appropriate remedies. While the Forest Research Institute can advise regarding methods of investigation most of this detailed work must be carried out by the provinces concerned.

In the Andamans the method of natural regeneration of mixed deciduous forest by removing the cover from below upwards which has been described in detail in a series of articles by Mr. B. S. Chengappa in the '*Indian Forester*' was examined by the Inspector General of Forests. This method has been extended over several hundred acres and has given excellent results. It will be incorporated as a definite silvicultural system in the new working plan. So far no success has attended the treatment of gurjan forest in a similar manner, the seedlings dying off. This matter is under investigation.

In Assam the rapid spread of *Eupatorium* is adding to the difficulties of regenerating *sal*. The parasite *Loranthus* has rendered it inadvisable to continue extensive use of *Gmelina* in plantations, and this pest is steadily increasing even on young *sal*. Alternate line mixture of *Terminalia myriocarpa* with *Lagerstroemia flos-reginae* promises good results.

In Bihar and Orissa the propagation of *sabai* grass (*Pollinidium angustifolium*) has now passed the experimental stage and a plantation of 100 acres is under formation. It should be noted that owing to the Calcutta paper mills using bamboos in substitution of *sabai* grass the artificial cultivation of this species should be proceeded with cautiously. Experimental plots for determining the best method of bamboo management were laid out with the collaboration of the Research Institute.

The most interesting feature of research in Bengal is the regeneration of gurjan in Chittagong by notching under a complete canopy after removing the low ground cover.' It has been shewn that the best time to sow a *Tephrosia candida* cover crop for *Dipterocarpus turbinatus* with *taungya* is with the final cleaning of the paddy at the end of July, resowing blanks after harvesting the paddy. The value of shading nursery beds of most evergreen species was demonstrated, and the possibility of winter planting with *Phoebe hainesiana* and *Polyalthia simiarum*. Experiments were initiated to regenerate *sal* artificially where there are no forest villages and labour is difficult to obtain, and preliminary results are reported. The best method of thinning young *sal* crops from strip sowings is further discussed and is still not finally settled. Experiments on climber eradication have been continued and figures collected shewing that the additional cost of removal of climber roots in a *taungya* is about Rs. 4 per acre and is recovered by savings under climber cutting in the first 2 or 3 years. Details are given of the 27 permanent preservation plots of forest types which have been set apart in the province. A great deal of experimental propagation of local and exotic species has been carried out.

Bombay has no separate post of Silviculturist, the work being carried out by divisional forest officers. Girth increment data for *Bombax* in the Panch Mahals division indicate an average annual increment of 1·12″ up to 48″ girth and an economic exploitable age of 30 years. This is very different to the 10 years estimated by a private planting company.

In Burma experiments were carried out to find out whether teak stumps could be used to advantage in Lower Burma *taungyas* where direct sowing or transplanting at stake is the usual method. Statistical analysis of the results proved that stumps planted on 24th May give far better average height than transplants put out on 9th June for

all stump diameters tried (*i.e.*, ¼" to 1¼" thick). A second series of stumps put out on 13th June did not do so well, this lead for small stumps dropped behind the transplants in height and survival. Root length is unimportant between 6" and 10". April planting was a complete failure except at one centre (Myohla) where it gave definitely better results than later dates. The teak seed origin experiments are shewing interesting differences between origins. Figures have been collected for shrinkage and for loss of bark of teak after girdling. Further entomological investigations are reported but little progress has been made towards finding some mitigation of the bee-hole borer which has done untold damage in teak plantations so much so that the financial soundness of making such plantations has been called in question.

In the Central Provinces investigations on the effect of various closure cycles and grazing incidences on forest pasture were continued with a new big series of small plots in Yeotmal division. A series of plots was laid out to study bamboo management problems in co-operation with other provinces. Natural regeneration of teak in the richer damper types of forest has been found almost impossible where dense bamboo or grass growth exists or becomes established as the result of fellings, whilst regeneration is usually most abundant in forests where the overwood contains a large admixture of miscellaneous species. Clear felling of dry mixed forests including teak is being found to increase the proportion of teak beyond what is desirable, as too pure a crop results in a dense growth of grass or bamboo and undue exposure of the soil; pole groups and advance growth of suitable miscellaneous species are now being retained for this reason.

In Coorg the cultivation of sandal does not appear to have given satisfactory results over a series of years. A small research station is being established to work in conjunction with the Madras Silviculturist. Investigations continue to be mainly on sandal and teak *taungya* work. The effect of burning and cutting back teak plantations in their second year is under observation.

In Madras valuable systematic research on planting technique for teak continues to be done. The advantages of premonsoon stump planting have been so definitely established by experiments over a series of years that the method can be safely recommended for all average conditions; the same method applied to other species such as *Dalbergia latifolia*, *Xylia xylocarpa* and *Pterocarpus marsupium* also gives satisfactory results though the gain is less than with teak.

The effect of the size of teak seed (fruits) was shewn to be relatively unimportant, and where seed is cheap the best nursery method is to sow very densely direct in the nursery beds. In the all-India teak seed origin investigation, only N. Kanara seed shews any signs of superiority over the local Madras origins. In planting out stumps in medium light

soils, soil working is unnecessary, crowbar planting giving nearly equally good results; similarly the expensive forking work hitherto practised gives little better results than cheaper weeding methods without soil working. Investigations to follow the history of replacements in gaps in a plantation shewed that few survive and these rarely get up into the general canopy.

The *rab* method has extended considerably in dry fuel forests, *Cassia siamea* being very popular for the work but not so drought hardy as hitherto believed.

Santalum album stumps have given good results with 98 per cent. survival after 3 years and good height growth.

Many underplanting experiments are in progress in the evergreen rain forests, but growth is extremely slow. With heavy rainfall, better results are obtained from late planting (August than early June-July).

In the North West Frontier Province progress in natural regeneration of blue pine has been shown to be dependent on a reduction of the depth of the unfavourable "A" horizon of the soil. Stump planting of walnut has been found to be very suitable. Controlled early burning of *chir* pine regeneration areas as a fire protection measure has been systematised with satisfactory results.

In the Punjab the natural regeneration of spruce and silver fir received much attention but so far very little definite results have been obtained. Seed storage experiments were carried out and a good deal of work done on the propagation of both hill and plains species. Tube planting experiments on a small scale for deodar, blue pine and *chir* pine gave promising results. *Prosopis juliflora* was found suitable for reafforestation work with *taungya* in dry *rakhs*. Plantation technique for *Tamarix articulata* from seed was studied in Montgomery division, and the propagation of this species from seed now presents no difficulty. August was found to be the best month for planting tamarix cuttings. Attempts to stock new areas in the irrigated plantations with *Morus alba* failed and it was again demonstrated that this species should be introduced under the shade of *Dalbergia sissoo* or *Tamarix articulata*. Numerous exotics were tried in Kulu division. Soil studies were made in spruce forests and in the irrigated plantations. The sample plots and preservation plots were kept in order.

In the United Provinces the large number of sample plots were maintained. Four new series of experimental plots were laid out to study the natural regeneration of *sal* with modern methods. *Quercus incana* has been found comparatively easy to coppice as also *Q. lanuginosa*, but *Q. dilatata* does not coppice well: this is important owing to difficulties experienced in the regeneration of the oak forests from seed. Artificial regeneration by *taungya* is becoming increasingly

important all over the province. The difficulty of excluding porcupine from plantations is recorded and the varying results obtained from planting *bhabar* grass are described. A large experiment (85 acres) has been started in Pilibhit division to see if the *chandars* can be afforested under *taungya*. The first season's results from the extensive series of resin tapping experiments in Kumaon are reported as also an investigation into the effect of tapping on diameter increment. Ten linear sample plots, one chain wide and aggregating over 13 miles long, were laid out for statistical studies in irregular crops.

In the domain of forest utilisation Assam is considering the appointment of a Forest Utilisation Officer, and it appears that the markedly increased demand for forest produce more than warrants such a step.

This Province also reports that *ping* (*Cynometra polyandra*) has been tried for vibratory screens in the Assam Oil Company's wells at Digboi in the place of imported hickory and is doing very well. *Michelia champaca* is in demand for furniture and has been found eminently suitable for the purpose, while *Podocarpus neriifolia* has been used with success for shovel handles.

Bihar and Orissa have been concerned chiefly with trying to find new markets for their forest products, and their efforts appear to be bearing fruit, more especially with regard to the sale of soft hardwoods such as *semul* (*Bombax malabaricum*), *salai* (*Boswellia serrata*), *tilai* (*Sterculia urens*) and other species for slate frames, and bamboos for paper-making.

This Province is also experimenting with pneumatic tyres for use on vehicles for extracting forest produce from sandy plantations. The results of this experiment will be of extreme interest to forest officers in other parts of India, the damage done by the iron-tyred Indian cart to forest roads being too well known to most forest officers to need further comment.

The Dunlop Rubber Coy. (India) have specialised in rubber tyred carts for India, and they have found that it is usually possible for one animal to do the work of two when pneumatic tyres are used. This innovation is therefore of interest to forest contractors also, especially as rubber tyred carts have now been designed to carry heavy loads like large logs and long poles on rough roads.

The Burma report is, as usual, full of interesting material. The chief activities of the year can be summarized as follows, but the report is so full of details and makes such interesting reading that a perusal of its pages is well worth while :—

(*a*) An enquiry in co-operation with the Burma Railways and the Forest Research Institute at Dehra Dun into the failure of teak sole bars (beams) in goods wagons.

(*b*) The investigation of a scheme for regulating the supply of Burma matchwoods by the factory demand, thereby improving the supply and increasing the revenue.

(*c*) A study of the variations in the quality of teak wood, with rate of growth, specific gravity, log size, locality of origin, etc.

(*d*) A consideration of the possibilities of standard grading of teak and other timbers, in liaison with the teak lessees, the Forest Research Institute, Dehra Dun, and the Imperial Institute, London.

(*e*) Numerous miscellaneous enquiries on Burma timbers, lac, *tung* oil, bamboos and other forest products.

One publication was issued by the Province. This was Pamphlet No. 8 "Note on *pyinkado* (*Xylia dolabriformis*), by F. Allsop, I.F.S.

The Central Provinces report a great improvement in the lac market. The yield rose from 1,314 maunds in 1932-33 to 2,554 maunds in 1933-34 and the revenue increased from Rs. 12,925 to Rs. 54,482 for the same years.

The gum of *Sterculia urens* (gum *karaya*) was also a good market, and 59,000 cwts. was exported from Bombay during the year, mainly to Japan.

Charcoal also proved profitable and heavy exports were made from several Divisions to Bombay.

The Forest Utilisation Officer in Madras reports an increase in the use of South Indian teak by the Railways for carriage and wagon work. It is also gratifying to note that the Madras Government have issued instructions to all departments under them to consult the Forest Utilisation Officer regarding their requirements of timber. A slight improvement in the timber market for the year under review is also recorded, the demand in the main being for teak, rosewood, irul, laurel, benteak and other hardwoods.

In the sphere of minor products a good deal of attention has been paid to the developing of markets for Madras lac and shellac. The Forest Department has also made successful efforts to sell sealing wax and wood polish made from lac in the North Salem division, and the Inspector General of Prisons has, as a result, issued orders that all jails in the Presidency are to buy their requirements from the Forest Department.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

ASSAM.

I. Experimental Silviculture.

(i) *General.*

As there was no improvement in the financial condition of the Province, the post of Silviculturist continued to remain vacant throughout the year and Mr. A. Das, I.F.S., carried on the duties of Silviculturist so far as possible in addition to his work on the preparation of the Flora of Assam.

(ii) *Natural regeneration including coppicing, root suckers, etc.*

(*a*) *Evergreen.*—In the Lakhimpur and Sibsagar divisions subsidiary operations have been carried out in the recently felled coupes in accordance with working plan prescriptions for assisting and inducing natural regeneration of the more valuable species. The method briefly consists in removing or opening the undergrowth and lower story canopy and in laying out a number of indicator and control plots for watching and recording the response to such treatment. The amount of regeneration to date is reported to be satisfactory particularly in the case of *hollong* (*Dipterocarpus macrocarpus*) and *nahor* (*Mesua ferrea*).

(*b*) *Sal* (*Shorea robusta*).—Progress has been hampered everywhere by the continued lack of seed. The situation in Kamrup is similar to that of the proverbial Curate's egg, so that both the optimist and the pessimist are lucky enough to be able to find gratifying proof in support of their particular contentions according to where they happen to search. The determining factor will undoubtedly be *Eupatorium*, apart from which regeneration would probably be achieved in bursts following each good seed year, and despite which considerable patches look like being successfully regenerated.

Progress in Goalpara, where systematic burning was started much later than in Kamrup, is difficult to estimate.

Sau (*Pollinia ciliata*) is certainly proving very recalcitrant on the Bhutan Frontier, but on the other hand the Terai Working Circle seems to be responding more than it was expected to.

The *Eupatorium* invasion of the Goalpara forests dates from 1927, and the weed is spreading rapidly in this virgin soil.

(iii) *Seeds (collection, weight, germination per cent, plant per cent, aids to germination, etc.).*

The following information is reported as regards *mekahi* (*Alseodaphne petiolaris*) :—

(1) Collection and sowing	September/October.
(2) Germination	1 month.
(3) Percentage of germination	43
(4) Height on 31st March 1934—	
Maximum	1'6"
Minimum	5"
Average	9"
(5) Weight—	
Fresh with pulp	92 per seer.
Dry with pulp	168 „
Fresh without pulp	216 „
Dry without pulp	360 „

(iv) *Nursery Work.*

In the Mikir Hills (Sibsagar), the following results were obtained from *Cinchona* seed sown on 4th April 1933 (see last year's report) :—

Species.	Amount of seed.	Number of plants and date.		
		1st pricking out.	2nd pricking out.	
		1st July 1933.	8th November 1933.	31st March 1934.
C. ledgeriana	2 oz.	685	558	553
C. succirubra	„	65	60	56
Hybrid of above	„	850	504	464

A further 3 oz. of *C. ledgeriana* was sown on 24th March 1934.

(v) *Artificial Regeneration, including taungya.*

In Plot 2 (Sibsagar) *jutuli* (*Altingia excelsa*) continues to thrive but the mixture with *gonserai* (*Cinnamomum cecidodaphne*) and *phulsopa* (*Manglietia insignis*) has not been successful and it appears that *jutuli* is better grown as a pure crop in accordance with its natural condition.

In Plot No. 7 (Sibsagar) *amari* (*Amoora wallichii*) was attacked by a shoot borer from which it was recovering at the close of the year.

Development has been slow. The plantation is now 6 years old and average height and girth 14′ and 6″—maximum 18′ and 10″.

In Plot No. 2 (Lakhimpur) *sam* (*Artocarpus chaplasha*) experiments were tried to show the effect of lines raised under shade and without and very little difference was noticed, probably due to the well distributed rain-fall of this district, for in the hotter and drier parts of the Province *sam* needs shade during its early years unless growth is to be retarded.

In the *Cinchona ledgeriana* plantations (Mikir Hills) referred to under 'Miscellaneous' last year, the present height of the plantation, now 5 years old, averages 15′.

(vii) *Tending.*

Thinnings, cleanings, climber and weeds.

(*a*) *Upper Assam Evergreen Type.*—The technique of tending and thinning in *hollock* (*Terminalia myriocarpa*) and *ajhar* (*Lagerstroemia flos-reginae*) plantations and *taungyas* is under careful consideration and experiment. In the sown strip there is a continued tendency to bend outwards inspite of the presence in the intervening space between strips of quick growing species such as *Mallotus*, *Macaranga* and grass. It has been suggested that, if wider strips were sown, there would be a larger proportion of straight stems in the centre, and that these could be best helped not by the removal but by pruning the leading shoots of competitors.

As regards the influx of climbers in such areas the density of the original sowings appears to be the main factor for consideration. Dense sowings undoubtedly tend to keep out climbers but such sowings are more expensive both in initial cost and subsequent thinnings, but where a lighter sowing has been tried there is the danger of not obtaining full stocking and the early introduction of climbers. This technique requires continued further study.

(*b*) *Sal.*—The principal enemy of young *sal* is the all-pervading *Eupatorium*, the best way of dealing with which is a matter of annual experimentation.

The *sal* in both Goalpara and Kamrup is heavily infested in places with *Loranthus*, which has steadily increased everywhere in the Province and on almost all species of trees during the last 8 years or so.

(*c*) *Miscellaneous Forests.*—The *gomari* (*Gmelina arborea*) plantations and *taungyas* in Sylhet and Cachar have been so severely attacked by *Loranthus scurrula* that this species will no longer be used except for filling-in vacancies.

(viii) *Mixtures.*

Hollock and *ajhar.*—This has been established as a satisfactory combination provided that the mixture is confined to alternating lines and not actually mixed in the lines. The reason being that *hollock* is a faster grower in the initial stages and prefers higher ground to that which is suitable for *ajhar.* The latter species will survive in low lying land which may be subjected to flood innundation. It may perhaps be contended that this is not a mixture in the true sense of the term although it is a combination of species as opposed to a pure plantation.

(ix) *Underplanting.*

Underplanting has not hitherto generally proved successful, and it appears to be the best policy for the time being to raise fast-growing species, especially in *taungyas,* in order to reduce the number of weedings.

II.—Working Plans and Statistics.

(i) *Working Plans.*

Mr. C. S. Purkayastha, A.F.S., continued to act as Working Plan Officer. The post of the second Working Plan Officer remained vacant during the year.

The working plan for the plains reserves of the Lakhimpur division south of the Brahmaputra was approved but owing to financial conditions could not be introduced in its entirety. A modified scheme has however been sanctioned in the meantime.

The Sadiya working plan was completed and approved and will be introduced from 1st October 1934.

BENGAL.

I. Experimental Silviculture.

(i) *General.*

Mr. C. K. Homfray, Deputy Conservator of Forests, was in charge of the division throughout the year. Mr. C. G. Trevor, C.I.E., Inspector General of Forests, toured Northern Bengal and saw most of the experimental and scientific work being carried out there. Mr. H. G. Champion, Central Silviculturist, toured Southern Bengal from the 5th November to the 7th December, and was accompanied by the writer. He visited all the more important plantations and inspected in detail all permanent

sample, experimental, garden, linear, and preservation plots. His advice on all matters was of great help and suggestions made by him are gradually being carried out as staff and money are available. Mr. C. E. Parkinson, Forest Botanist, inspected most of the linear sample plots of Northern Bengal and helped with the identification both of unknown trees in these lines, and of the more important undergrowth found in our plantations. The visits of such officers are an enormous help to this Province and such tours are greatly appreciated.

(ii) *Natural Regeneration.*

(*a*) *Dipterocarpus spp.* (*garjan*).—Experiments in natural regeneration and natural *cum*-artificial regeneration of *Dipterocarpus turbinatus* and *D. costatus* were continued in Chittagong and Cox's Bazar divisions. This year's experiments confirmed last year's conclusions that the best method of aiding natural regeneration is by *notching* the seed of *Dipterocarpus turbinatus*—a process of making a hole in the ground with the point of a *dao*, placing the seed in the hole and just covering up the seed with earth. Broad-casting seed without hoeing is a complete failure, and the results of notching are far superior and cheaper to broadcasting with hoeing. Notching of the seed should be done under the top canopy after removal of all other storeys and the cutting and burning of the undergrowth. Experiments dating back from 1931 look extremely promising and have given surprisingly good results at a low cost and this method prevents the invasion of the area with *Eupatorium* and diminishes the cost of cleanings.

Constant failure has been experienced with *Dipterocarpus costatus* as it ripens its seed too early and about 99 per cent of hand picked seed still fail to give seedlings, apparently due to insect attack. Small-scale experiments with deep 'notching' will be undertaken during the current year as suggested by the Central Silviculturist.

In plots where annual burning of the undergrowth is the only treatment carried out, the evergreen undergrowth is gradually being replaced by *Imperata* grass, but adequate natural regeneration (*Dipterocarpus costatus*) has not yet resulted.

(*b*) *Evergreen forests.*—The plots mentioned in the last three years reports were maintained in the Kasalong reserve of the Chittagong Hill Tracts division. Nothing will be more appropriate than to quote extracts from the Central Silviculturist's report that deals with the condition of these plots, including a very brief outline of their past history, suggestions for future treatment, and how far some of them have already fulfilled their objects and given ascertained facts :—

"Regeneration of important trees is definitely abundant up to the sapling stage though the middle diameter classes are scarce. Experi-

ments were begun in 1930—E. P. Nos. 4 and 5, and 1931—E. P. Nos. 10 to 17—to determine a method of removing the existing overwood which would ensure satisfactory natural regeneration. These plots have already yielded useful information. The canopy was viewed as of four tiers *counting from below* and the following operations were done :—

E. P. No. 4.—Un-treated control.

E. P. No. 5a.—Undergrowth (to 20 ft. high) cut back and 2nd and 3rd storeys thinned considerably.

E. P. No. 5b.—Undergrowth cut-back.

E. P. No. 10.—2nd and 3rd thinned, 1st and 4th untouched.

E. P. No. 11.—Undergrowth and 3rd (except valuable species) removed.

E. P. No. 12.—As E. P. No. 11, but burnt.

E. P. No. 13.—Untreated control.

E. P. No. 14.—All removed except 4th, and seed-bearers of good species in 3rd and 2nd.

E. P. No. 15.—Storeys 1, 2, and 3 removed except seed-bearers which were afterwards girdled (*a*) before seed-formation, or (*b*) after seed-formation.

E P. No. 16.—Trees of all storeys removed except *civit* (*Buchanania lancifolia*) and *gurjan* (*Dipterocarpus turbinatus*) in the 4th which were girdled, and undergrowth cut.

E. P. No. 17.—All inferior species in 2nd and 3rd storeys were girdled.

Several of the plots were evidently too heavily felled as shewn by the dense growth of weeds and creepers including *Eupatorium* and *Macaranga*—this is true of plots 14, 15 and 16 which have served their purpose and may be closed down. If the lower canopy is opened up too heavily, the regeneration may respond well at first but will then be swamped by the stimulated weed growth (E. P. No. 14). It is also evident that the bottom storey should be the first removed as lightening of the higher storey is responded to more by the weeds than the regeneration (E. P. No. 10). At present the indications are pretty definite that the correct procedure will be to begin with the lowest canopy freeing seedlings and saplings from competition for light and space and to work upwards in stages yet to be determined. It should be possible to bring the regeneration on to a considerable extent by removal of inferior or fuel species only so that the usual abundant regeneration can be established and got into a condition when it will be able to compete with the heavy weed growth which is the inevitable consequence of opening up the high canopy layers, leaving

the exploitation of commercial timbers to a later stage when perhaps heavy fellings can be done, as may be necessary to keep down extraction costs. Regeneration work should accordingly precede exploitation felling. Burning is certainly a mistake (Plot 12)."

(*c*) *Hopea odorata.*—As has been reported already, natural seedlings of the year were noted in 1930 in great profusion under certain seed-bearers at Hazarikhil, Chittagong division. These were freed from weeds in 1931, and in 1932 the canopy was removed over one plot 9a, and left in the other 9b. The average height of the plants at the end of the successive growing seasons has been 7″, 14″, 23″ and 42″ in the open plot and 7″, 13″, 17″ and 21″ in the shaded plot. This regeneration is, as the Central Silviculturist remarked, "remarkably dense and uniform and has responded very effectively to cleanings and to the removal of the canopy".

(*d*) *Shorea robusta.*—E. P. No. 16 of Buxa division. This plot was laid out in 1931 to discover if by opening up the canopy and the removal of all species except *sal*, and by burning the undergrowth annually it would be possible to obtain natural regeneration of *sal*. At the time of laying out the canopy consisted of scattered *sal* and its deciduous associates, and the undergrowth mainly of a dense mass of *sau* grass (*Pollinia ciliata*) about waist high, with scattered *Clerodendron infortunatum*, *Coffea bengalensis*, *Leea robusta*, etc. At the end of the first year after this operation, the *sau* grass was found to be extremely dense up to 6′ high. After burning for four years in succession, the *sau* has at last become fairly thin and about knee deep,—*Anthisteria gigantea* has come in, in large quantities, also some *Panicum plicatum* and *Saccharum spontaneum*. There has been no recruitment of *sal* seedlings during the period.

(*e*) In the Buxa division, the experiments in burning annually the *sau* grass areas in the Bhabar tract with a view to obtaining natural regeneration of *sal* were continued. In these plots the canopy was untouched, and after 5 burns there appears to be very little change in the undergrowth. There is no appreciable recruitment of *sal* seedlings.

(iii) *Seeds.*

(*a*) Seeds of exotic species for experimental purposes and seed for plantations were supplied to divisions through the Silvicultural division.

(*b*) Seeds were also supplied to different Provinces in India and abroad.

(*c*) Seeds of valuable timber species for experimenting with in the hills were secured through the Forestry Commission, England, and from

Canada, America, and Russia, the last mentioned country supplying, during the year under review, over 12 samples of different seeds free of cost.

(iv) *Nursery Work.*

Three separate silvicultural nurseries and gardens are maintained by the Silvicultural division. The routine tests are nursery beds with and without shade, and comparison between direct line sowing, transplanting and stumps. These are repeated as far as possible for four years running so as to obtain average results. In addition in the Hazarikhil garden in the Chittagong division—*bogamedeloa* (*Tephrosia candida*) is sown in between the lines over half the area in May. Lines are so run as to keep the beds of direct sowing, transplanting, and stump-planting partly in the open and partly under the shade of *bogamedeloa*, so as to compare the relative rate of growth, of each species with and without shade. Also such data as to weight of seed, method of treating seed, germination and plant per cent are recorded for all species put out in the three nurseries. The information obtained is of immense value to this Province, which depends so largely on artificial regeneration.

(i) Hazarikhil in the Chittagong division, for experiments with indigenous species suitable for plantations in the Chittagong division.

In the nursery, observations continued to be taken on species sown in 1931 and 1932 as mentioned in the tabular statement of the last two years report.

The following species were tried :—

Dipterocarpus pilosus, D. alatus, D. turbinatus, D. costatus, Eugenia cymosa, E. grandis, Dichopsis polyantha, Hopea odorata, Swietenia macrophylla, Pterocerpus dalbergioides—all with fair to good results—*Terminalia myriocarpa* and *Vitex peduncularis* with poor results, and *Castanopsis indica* and *Calophyllum polyanthum* for which no germination was obtained. Most of these species were sown direct in the garden and also transplanted from the nurseries, the results calling for no special comment except that *Dipterocarpus pilosus, Hopea odorata* and *Swietenia* transplants appeared to benefit from *bogamedeloa* shade.

Stump planting is usually done with one or two year old nursery stock. The following conclusions have so far been arrived at from the results of the last three years repetitions :—

Dipterocarpus turbinatus.—Stump planting is quite successful although condition and growth is not so good as by direct sowing or transplanting.

Dipterocarpus pilosus.—Stump planting is quite successful although condition and growth is not so good as by direct sowing or transplanting.

Dipterocarpus costatus.—Stump planting has failed so far.

Dichopsis polyantha.—Does not stump well.

Hopea odorata.—Success is nearly cent per cent, attaining about the same height in a year as plants from direct sowing.

Lophopetalum fimbriatum.—It can be stumped very successfully, condition of plants and height growth being similar to those raised by direct sowing or transplanting.

Artocarpus hirsuta.—It stumps well.

Swietenia macrophylla.—Fairly successful, but not so good as direct sowing or transplanting.

Pterocarpus dalbergioides.—Fairly successful, but not so good as direct sowing or transplanting.

Vitex glabrata.—Very successful, almost cent per cent success.

Vitex peduncularis.—Less promising than *Vitex glabrata*, although it stumps fairly well.

Taraktogenos kurzii.—Cannot be propagated by stumps.

Eugenia grandis.—The one set of stumps tried so far has not done well.

Mesua ferrea—Stumping has given low survival and poor height growth.

(ii) Sukna in the Kurseong division, for experiments with species both indigenous and exotic suitable for the plains and foot-hills of Northern Bengal.

Twenty-one species were under trial. Shading was found to benefit most species tried particularly the evergreens, though *Saccopetalum longiflorum* was a surprising exception in this respect. Shade was of no assistance to *Sterculia campanulata* and *Sterculia alata* and was harmful to *Trewia nudiflora.*

Interesting comparative results were obtained between direct sowing, transplanting in the monsoon and in winter, and stump planting. The complete failure of *Phoebe attenuata* stumps and the success of winter planting (70 per cent) with *Phoebe hainesiana* and *Polyalthia simiarum* may be mentioned.

A large number of species are under trial but it is too early to report on results.

(v) *Artificial Regeneration.*

(*a*) Regular and *taungya* plantations in the Chittagong and Cox's Bazar divisions.

The following garden plots were maintained during the year :—

Garden plot No. 17.—The object is to study the rate of mortality of *Dipterocarpus turbinatus* seedlings when grown in a regular plantation with *bogamedeloa* as a cover crop, and treated under the divisional method. The experiment started with 667 plants in 11 lines in August 1932, and the number of plants decreased to 512 in May 1933 and to 404 in November 1933, mortality being 39 per cent in the 2nd year. Further observations will continue.

Garden plots Nos. 15 and 16.—Two plots were laid out in the 1932 regular plantation of *Eugenia grandis* (*dakijam*), one with and the other without *bogamedeloa* as a cover crop, with the object of studying whether shade is necessary to raise this species and also to compare the effect of shade on the growth of the *dakijam.* Although the open plot looked inferior at first, both have since developed quite well. It was noted that the percentage of mortality was higher in the open plot than in the shaded, and that light shade at the initial stage, rather than dense shade, is very helpful, particularly during the first hot weather.

Garden plot No. 18.—A new garden plot has been laid out in the 1933 regular plantation at Bhomariaghona for *telsur* (*Hopea odorata*).

Experimental Plot No. 18, at Hazarikhil.—*Dipterocarpus turbinatus* (*gurjan*).

Sub-plot A . . .	*Bogamedeloa* sown broadcast in between the *gurjan* lines after the last cleaning of *paddy* in August 1933.
Sub-plot B . . .	*Bogamedeloa* sown in hoed up lines in between the lines of *gurjan* after *paddy* was reaped in September 1933.

Observations towards the close of the year showed that the stocking of *bogamedeloa* was quite good in both the sub-plots ; but while the height growth in the sub-plot A indicated the possibility of affording shade to the *gurjan* during the coming hot weather, that in the sub-plot B did not. The results of the two years' experiments have proved that the best time to put out *bogamedeloa* in *taungya* plantations is between July and August with the final cleaning to the paddy, and that instead of scattering the seed broadcast it should be notched in by scraping up the soil with end of a stick or sharp instrument so preventing the seeds from being washed down the slope. Any inadequate stocking can be beaten up later on as soon as the paddy has been reaped.

(*b*) *Bamboo experiments* (Baraiyadhala, Chittagong division).—The western aspect of the Ramghar-Sitakund range is formed of soft tertiary sand stones and shales dipping eastwards so that the drainage is very

complete and carries a definitely dry decideous type of forest. Denudation is heavy and the soil is poor and shallow. *Muli* (*Melocanna bambusoides*) now occurs only in ravines higher up the ridges. From reports it would appear that bamboos at one time covered nearly the whole of this ridge but have gradually been destroyed by over-cutting and grazing. Experiments are now being made to see if it is possible to reintroduce bamboos under the present existing canopy. E. P. No. 17 was laid out early in 1933 at the foot of the ridge, the undergrowth was cut and burnt and the canopy thinned. Seeds of *muli* were sown at stake but were stolen by outside villagers. Rhizomes of *muli* and *mitenga* (*Bambusa tulda*) were put out 12′×12′ in holes dug 3′×3′×3′. These were inspected in March and have still the hot weather to go through, the *mitenga* were looking quite healthy but the *muli* were already showing signs of drying up. It was noted that those rhizomes which had big healthy buds sent up vigorous healthy shoots soon after planting, while those with poor buds took a long time to develop and would not appear to be sufficiently established to stand the hot weather. Great care should be taken in the selection of rhizomes. Experience has shown that it is better not to clear and burn and that the canopy should not be interfered with more than necessary, otherwise the soil is eroded and bamboos are unnecessarily exposed during the hot weather.

(*c*) *Michelia champaca* (*champ*).—Experiments carried out again this year show that even under the shade of *bogamedeloa* it is impossible to get any real success with direct sowing of *champ*. The putting out of young seedlings in plantations at the time of pricking out in the nursery in October-November when about 3″ high only gave 5 per cent success. On the other hand winter transplanting of 5″ high seedlings in January from seed sown in the nursery the previous August (5 months old) has given complete success. It is advisable to put up little shades to each plant on the south by fixing up a few cotton stalks about 1½′ long stuck in the ground with some paddy stalks laid against them.

(*d*) *Sal plantations*.—Thatch grass (*Imperata arundinacea*) often comes up as a heavy undergrowth in *sal* plantations and although the area is fully stocked with seedlings, the rate of growth of the *sal* is slow. In fact, in areas where the thatch grass is particularly dense, the *sal* remains in a whippy stage. Experiments were carried out by the Silvicultural branch and the Divisional Forest Officer, Jalpaiguri division, to see if by burning the grass, giving the area a hoeing, and coppicing the seedlings, and in addition doing a rains weeding, it would be possible to get the *sal* above the level of the grass. In one plot where only burning and coppicing was done the thatch grass came in again thicker than ever and the *sal* still remained in the whippy stage, but in the plots where hoeing and rains weeding was carried out in addition, the grass was found to be practically absent the following March and the *sal*

seedlings looked extremely healthy with good 'carotty' shoots. The larger seedlings, those from 4′ to 5′ failed to reach their original height after coppicing, but the smaller seedlings from 8″—3′ increased their original height considerably. The Divisional Forest Officer, Jalpaiguri, reports that in areas so treated the *sal* was free of *gulancho* (*Tinospora cordifolia*) though every plant outside the plot was infested with this troublesome climber. The experiments are being continued to see if any treatment will be required in the second year.

(*e*) *Cover crops in Northern Bengal.*—Experiments with species likely to be suitable as cover crops in *sal* plantations with the object of suppressing weeds and climbers and so reducing the cost of weeding and cleaning were carried out in the Silvicultural garden and 1933 plantations at Sukna-Kurseong division.

Clerodendron infortunatum was again repeated on a small scale, and as this species shows distinct possibilities as a cover crop, larger scale experiments will be carried out in divisional *sal* plantations this year.

Napier grass (*Pennisetum purpureum*) and *Cassia tora* were tried on a larger scale. *Napier grass* has to be cut back two or three times a year and although it would appear to be an excellent cover crop, it should only be used in areas where fodder is saleable so as to save the cost of otherwise unremunerative cuttings. *Cassia tora* does not appear to be suitable in so far as it has not resown itself satisfactorily in between the lines in the second year as was expected. This species dies back in October-November and germination of the self-sown seed does not appear to start until the following May, in the meantime a certain amount of weed growth comes up in between the lines, and it would appear that the seed will not germinate under the shade of these weeds.

Leucaena glauca was tried on a small scale by sowing seeds with inoculated soil. The seed and the soil were mixed in a basket and sown thickly in 1′ wide lines in between the *sal* lines. It appears to be doing well but it is too early to draw any definite conclusion.

Tephrosia purpurea is also being tried; if it does not grow too high, may save the cost of coppicing back each year which is the drawback with *Tephrosia candida.*

(*f*) *Artificial regeneration of sal without cultivators at Raimatong and Buxa Road in the Bhabar Tract, Buxa Division.*—Experiments were carried out in accordance with the recommendations of the Central Silviculturist given in the Indian Forest Records, Vol. XIX, Part III, "Regeneration and management of *sal*," page 63, para. 3.

The following different methods of treatment were carried :—

Plot 1.—The whole area was hoed and weeded and all grass roots were pulled up and burnt.

Plot 2.—Same as (1), except that grass roots were not burnt.

Plot 3.—Hoeing, weeding and burning of grass roots, etc., done in 3′ wide lines only, leaving 6′ wide lines untouched in between.

In plots (1), (2) and (3) *sal* seed was sown in 3′ wide bands 6′ apart, there being 9 or 10 rows of *sal* seeds in each band, the seed being sown 2″ apart in each line.

Plot 4.—Ordinary regular *sal* plantation. The area was hoed up, weeded and grass roots, etc., burnt. *Sal* seed was sown in 2′ wide bands 6′ apart and cotton was sown in between the lines.

Plots (1), (2) and (3) were sub-divided into 1*a*, 1*b*; 2*a*, 2*b*; 3*a*, 3*b*. In plots 1*a*, 2*a*, 3*a*, no rains weeding was done, but in 1*b*, 2*b*, 3*b*, one rains weeding was done in July, which consisted of the pulling up of the roots of grass within the three foot bands of *sal* and cutting back of the grass in between the lines. Plot 4 was weeded whenever necessary. Cost in terms of number of coolies was kept for each sub-plot. It was an exceptionally bad *sal* seed year, and seed had to be brought from a considerable distance. Nevertheless all plots were sown up and detailed notes were made of the several experiments.

Taking everything into consideration plot 4 (regular plantation) and plot 1*a* in which the area was completely hoed up and grass roots burnt and no rains weeding done, appear the most satisfactory areas.

Evergreen area.—One rains weeding has obviously helped in all the (*b*) plots, the plots in which no rains weeding was done are smothered in weeds and *Assam-lota*.

Again taking everything into account plot 4 (regular plantation) and plot 3*b* in which hoeing and weeding was done only in the 3′ wide bands and one rains weeding carried out, appear the most satisfactory areas.

Teak (*Tectona grandis*) and *panisaj* (*Terminalia myriocarpa*) were also tried in the evergreen area. *Teak* was sown at stake; direct sowing is too slow and this species should be propagated by cuttings in future. *Panisaj* was only successful where rains weedings were carried out as this species cannot stand any suppression by weeds.

(*g*) *Experiments with different species* carried out in 1932 in the Kalimpong foot-hills by Mr. R. I. Macalpine, the Divisional Forest Officer, Kalimpong division, have given certain results. *Gokul* (*Ailanthus grandis*) can be sown direct with success. It is fairly fast growing but inclined to be irregular, 3′ to 6′ in 21 months. *Lepchapat* (*Polyalthia simiarum*) can also be sown direct with success, but growth is slow averaging 2′ in 19 months. From observations it would appear to suffer from direct exposure to the sun and should be tried with *bogamedeloa* or

in an intimate mixture with a fast-growing species like *panisaj*. *Angari* (*Phoebe attenuata*) transplants are much more satisfactory than direct sowing. It is a shade demander and appears to be doing fairly well planted with *panisaj* in alternate lines 3′ apart, and should eventually make a good understorey. *Angari* was also tried with *bogamedeloa* as a shade crop and the Divisional Forest Officer reports that this appears to be the best method of raising this species and with few exceptions the growth of the seedlings is good. *Mallata* (*Macaranga denticulata*), as mentioned in last year's report, germinated extremely well from direct sowing in the 1932 plantation, Chunabhati and in March 1933 the average height was 12′. This species was tried again in 1933 but with very poor results.

(vi) *Reclamation and Afforestation.*

Experimental *taungya* plantations of *sal* and *chapalish* (*Artocarpus chaplasha*) have been made by the Divisional Forest Officer, Dacca-Mymensingh division, in order to try and afforest certain blanks in the division.

(vii) *Thinning and Cleaning.*

(*a*) The following notes by the Conservator of Forests, Bengal, regarding thinning in *sal* plantations may be of interest :—

" *Thinning in Sal.*

I must revise my views on *sal* thinning since the circular on this subject issued by me in 1931. At that time I recommended the removal of nothing but (1) *kukat*, (2) *wolf trees* and the few co-dominants that might be found in the 5th year and making no real thinning until the 8th year, or even later, according to the growth of the plantation. The idea underlying this order was my belief that the trees of the future would have declared themselves by the 8th year. Another point which I made at that time was that to remove the suppressed stems in the 5th year served no useful purpose and by inducing a luxuriant growth of climbers just at the time that they are most destructive, it would increase this damage as well as the cost of climber-cutting.

As regards the lightness of the crown thinning then recommended it is true that trees of the future declare themselves noticeably about the 8th year but a comparison between the plantations heavily thinned in their 5th year and of those treated as I then suggested shows that, in the former, the dominants are far more numerous and therefore better spaced for future thinnings.

As regards the question of clearing or leaving suppressed stems two arguments have since been advanced firstly, that dense shade may

encourage rather than deter the worst species of climbers in *sal* forest though the reverse appears to be the case in dry mixed and river forests, and secondly, that the cutting out of suppressed stems greatly assists climber-cutting which is then both cheaper and more effective. Such figures as we have seem to point to this conclusion but more definite and reliable data will be available shortly as one half of each plantation thinned for the first time this year is being cleared of suppressed stems which are being left in the other half.

In addition to these apparent advantages, there is no doubt that thinning is rendered quicker and more efficient by the removal of suppressed stems by coolies cutting ahead of the marking officer.

It is further urged that, if our object in burning is to change soil conditions, direct sunlight will be necessary and that, in fact, burning without reducing shade does little more than change the vegetation to a more fire resisting type without affecting the soil. This sounds probable but remains to be demonstrated.

I still agree with my note of 1933 as regards the 2nd thinning of *sal*, that is to say, it should be a heavy thinning, removing not only the suppressed but a considerable proportion of the dominated stems as well as the usual crown thinning. As regards the date of this second thinning, though it has been laid down for the 11th year, with a heavy first thinning it may be possible to delay this and to save money and get more utilizable produce."

(*b*) A set of thinning plots were laid out in *Terminalia myriocarpa* last year both to study the volume increment per acre under the different grades of thinnings and to see if heavy thinning would encourage the luxuriance of the climbers. After one year the plots were inspected and there was found to be hardly any difference in climbers between the heavily thinned plot (C grade) and the unthinned control. In fact climbers seemed more frequent in the unthinned control as they were mainly confined to the suppressed stems which had been removed in the heavily thinned plot.

(*c*) Experiments were carried out by the Silvicultural branch and by the Divisional Forest Officers, Jalpaiguri and Kurseong divisions, to discover the best method of eradicating climbers in plantations.

From experiments on this work up to date the following conclusions have been arrived at :—

1. The roots of dangerous climbers are already in the soil before *taungya* operations begin. Seedling climbers do not develop in time to be a menace to a plantation during the dangerous (fourth and fifth) years and can be dealt with by pulling up.
2. It is not practicable to uproot climbers once *sal* has been sown.

3. When a plantation is hoed as in departmental *taungya* the additional cost of removal of roots to a depth of 9″ (about Rs. 4 per acre) is recovered by savings under climber-cutting in the first 2 or 3 years.

(*d*) *Experiments in controlled burning in sal plantations.*—Most plots have been burnt 3 years in succession and the following is a brief summary of results up to date :—

Condition of undergrowth.—As the result of burning, the undergrowth in the burnt plots has been greatly reduced, and whereas at the time of laying out it was usually from knee to over waist deep, now it is seldom over 1′-6″ high at the most and in some plots the soil is completely bare except for a few ferns. At the time of laying out the chief species in these plots were ferns (3 varieties), *Piper* sp., *Phlogacanthus thyrsiflorus*, *Boehmeria* sp., *Premna bengalensis*, *Amoora rohituka*, *Litsaea polyantha*, *Sterculia villosa*, *Aralia* sp., *Indigofera* sp., *Machilus* sp., *Urena lobata*, etc., these have now been changed for a drier type of associate such as *Imperata arundinacea*, *Pollinia ciliata*, *Cleredendron infortunatum*, *Coffea bengalensis*, *Ageratum conyzoides*, *Litsaea polyantha*, *Leea crispa*, *Careya arborea*, etc. The undergrowth in the unburnt plots appears to be getting denser chiefly due to the increased presence of ferns and to natural regeneration of such species as *Machilus villosa*, *Ficus* spp., *Amoora wallichii*, *A. rohituka*, and *Dysoxylum* spp.

Condition of climbers.—The number and density of climbers have been considerably reduced in the burnt plots partly due to burning and partly to the fact that the burnt areas being cleaner, climber-pulling has been easier and more effeciently carried out. The cost of climber-pulling has been reduced by half in some of the burnt plots. The principal climbers now occurring in the burnt plots are *Tinospora cordifolia*, *Milletia auriculata*, *Smilex* sp., and *Spatholobus roxburghii*.

Growth of sal.—Only one set of plots has been measured up to date (E. P. No. 14 A, B, C—of Buxa division). Plot 14A had been burnt for 5 years in succession, plot 14B is the unburnt control, and plot 14C was burnt biennially. Volume figures for each sub-plots were calculated at Dehra Dun and there is no appreciable difference in the rate of growth in any of the plots. More will be known on this point when the remainder of sets of plots have been remeasured. The canopy of the burnt plots is lighter due to the dying out of suppressed and badly dominated stems from the effects of burning.

(viii) *Mixtures in Plantations.*

The following experiments started by Mr. N. Pal, Deputy Conservator of Forests, have been continued for the past three years in the Chitta-

gong Hill Tracts division. *Gamari* (*Gmelina arborea*) has been put out in alternate lines with shade-bearers and semi-shade-bearers—such as mahogany (*Swietenia macrophylla*), *gurjan* (*Dipterocarpus turbinatus* and *D. pilosus*) and *tali* (*Dichopsis polyantha*) with the chief objects of affording shade to the shade-bearers during their first few years, and at the same time to help keep down such light demanding weeds as *Assam-lota* and so save cost of cleanings. *Gamari* is treated principally as a secondary species with a possibility of retaining a few stems as a part of the crop, and so will be removed as soon as it interferes with the growth of the other species. Observations up to date show that both *gurjan* and *tali* do well under a light shade of *gamari* and that the growth of weeds especially *Assam-lota* is to a certain extent kept in check. Mahogany on the other hand is liable to be suppressed and if *gamari* is grown with this species it will have to be so widely spaced that it can no longer afford sufficient shade to keep down the weeds.

(ix) *Underplanting.*

A full note was given under this head last year. Experiments up to date have proved that although certain species can be underplanted with success, the cost of establishing (weeding and cleaning) the under-crop is usually so heavy as to make it financially impossible on a large scale. Consequently all plots were abandoned except those that really showed a promise of success.

(xi) *Miscellaneous.*

(*a*) *Co-operative investigation on the origin of teak seed.*—The results of the 1932 experiments were poor owing to the heavy invasion of grass and it was therefore decided to repeat these in 1933. The 1933 plots are not all on quite so uniform a site, but should do well enough. Nilambur is again going up well, and South Burma next best. The Bombay origins continue to give trouble and germinated much later than the others. Last cold weather enumerations showed the following percentage of success (calculated in terms of stakes) in the different plots under each origin.

Experimental Plot Nos. 33 to 39, Chittagong Hill Tracts division—

	Per cent.
Bombay.—E. D. Kanara	75 to 80
W. Khandesh	85
Madras.—Nilambur	90
Bengal.—Kaptai	90
Burma.—Myitkyina	80 to 85
Tharrawaddy	90

Blanks will be filled up during the rains of 1934 from plants of different origins left in the nursery beds.

(*b*) *Rot in root-and-shoot-cuttings of teak.*—The use of stumps is established and the possibility of resultant rot is under systematic study with three adjoining plots (Experimental plot Nos. 28, 29 and 30) in the 1932 plantation at Kaptai, Chittagong Hill Tracts, raised by direct sowing, transplanting and stumps respectively. A representative stem from each is being sent to the Forest Mycologist at Dehra Dun annually. So far there has not been any sign of rot.

(*c*) *Bambusa tulda* and *Melocanna bambusoides Experimental plots at Inoni, Cox's Bazar.*—A set of plots E. P. Nos. 15 and 16 were laid out to discover the best rotation for cutting, and to study the effects of cleanings. There were a large number of standing dead and defective culms and the general appearance of E. P. No. 15, which has been cleaned at a cost of Rs. 4 per acre, suggests that this operation will result in the production of considerably more exploitable culms.

(*d*) *Preservation Plots.*—In accordance with the Resolution No. 22 of the 3rd Silvicultural Conference held at Dehra Dun in 1929, 27 Preservation plots have been laid out in Bengal in various types of forest.

(*e*) *Loranthus* (*Loranthus scurrula*) in plantations.—The attack on *gamari* (*Gmelina arborea*) in the Chittagong Hill Tracts division is subsiding. The attack has been worst on low wet areas unsuitable for *gamari*, and it is generally the small crowned trees that are killed. More care as to choice of site, and heavy thinning so as to produce large well formed crowns would appear to be the best preventive. *Toon* (*Cedrela toona*) in the Madarihat plantations of the Jalpaiguri division, and at Godamdabri in the Buxa division are now being badly attacked by the same species of *Loranthus* and some quite healthy trees have been killed out.

(*f*) *Urostylis punctigera* on *champ* (*Michelia champaca*).—The damage from the pest was very severe indeed during the year under review, especially in the Kalimpong foot-hills, where plantations in the past had been particularly free from it, but after last year's attack there is hardly a plantation that has not been affected. The Inspector General of Forests sanctioned a scheme during the year for the investigation of this pest by the Forest Entomologist, Dehra Dun. The Forest Entomologist toured the affected areas in the Kalimpong division last October, and started an insectary at Samsing with two field assistants in order to study the life history of the bug. The Assistant to Entomologist, Dehra Dun, also toured the *champ* plantations of Northern Bengal twice during the year. The results of these investigations will be awaited with interest.

II.—Working Plans and Statistics.

(i) *Working Plans.*

(*a*) The revised working plans for the Sundarbans and Kurseong divisions are with the Press.

(*b*) The revision of the Kalimpong and Chittagong working plans were taken up during the year.

(ii) *Yield Tables, etc.*

The province now maintains 193 permanent sample plots, 19 diameter increment plots, 17 linear sample plots, 84 experimental plots and 27 preservation plots distributed over all divisions. 50 of these are new plots. Observations have been made in the majority of the rest during the year under report.

III.—MISCELLANEOUS.

(*a*) *Nursery notes.*—A new issue of "Nursery and Plantations Notes for Bengal 1933" was received from the Press during the year and distributed to divisions and other Provinces.

(*b*) *Ledger filing.*—Ledger filing of all matters of silvicultural interest and publications received, was carried out. There are now 168 specific files and 130 General Ledger files maintained in the office.

(*c*) Records of all measurements of sample and diameter increment plots were sent to Dehra Dun for compilation of volume figures, and all observations in experimental plots were recorded and tabulated.

(*d*) Many photographs of silvicultural importance were taken or received both from individual forest officers, and from the Central Silviculturist, Dehra Dun, during the year. There are at present 340 photographs of silvicultural importance in the Provincial silvicultural collection.

(*e*) The very active co-operation of the Divisional Forest Officers and Range Officers throughout the Province has been much appreciated. The help given by Dehra Dun and other Provinces is also gratefully acknowledged.

BIHAR AND ORISSA.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

During the year under review work has continued on the same general lines as during the past 2 or 3 years. The same need for economy has continued and is shown in the smallness of the staff employed. During the year the Forest Research Officer, who is responsible for economical research and development as well as entomological, mycological and silvicultural research, has been relieved of all working plan duties so that for the first time for 3 years he has been relieved of extraneous work.

The smallness of the research staff (one officer-in-charge, one Forest Ranger and two clerks) as well as changes in the person of the Forest Research Officer had made strict control of records and field work difficult. Territorial Divisional Forest Officers had been allotted a larger share in the upkeep of experimental plots. Lack of close co-ordination and curtailed touring by the Forest Research Officer has resulted in considerable confusion in both field work and record of data in experimental plots.

A draft triennial programme was issued for opinion of territorial officers at the end of the year. In finally settling this programme of work, not only will unessential problems be sifted, but a scheme evolved whereby territorial officers will have more experiments under their direct charge, only advice, scrutiny and summation of results being vested with the Forest Research Officer.

But even with careful reorganisation on these lines, it will probably be impossible to cope with existing and accruing field work in the statistical sample plots now in existence or conception. Sample plots have to be remeasured every 5th year while some experimental plots require annual remeasurement. This work cannot be left to divisional staffs, and it seems impossible so to organise work as to limit touring of the Forest Ranger in only one group of divisions each year. The time lost in touring and the possibilities of illness make it essential for one extra subordinate to be attached to the Division.

The Officers-in-charge of the Research Division during the year were—

1st April to 8th October 1933—Mr. B. P. Basu, I.F.S.

9th October 1933 to end of the year—Mr. F. C. Osmaston, I.F.S.

Babu Vidya Sagar Sharma was the attached Forest Ranger throughout the year.

Interesting results achieved or in progress during the year 1933-34 are summarised below.

(ii) *Natural Regeneration.*

Efforts are being made to discover how to regenerate *sal* (*Shorea robusta*) naturally in the evergreen forests of the Banpur Mal of the Puri division. From records these forests seem to have contained adequate regeneration 20 or 30 years ago. It appears that fire protection in these generally humid forests is resulting in a progression from a *sal* type to an evergreen type of forest.

Experimental plots 3, 4, 5 and 6 laid out in 1924, 1925 and 1926 are now showing some results. They do not give any numerical data, but ocular evidence as recorded by several observers is more or less unanimous that annual fires check and slowly eliminate evergreen competitors and

provide a more suitable regeneration bed for *sal*. But there is a tendency for *Macaranga deltata* to form a dense crop, while *Ageratum conyzoides* also forms in many places a dense cover and these two species (whose domination may only be a temporary phase) in their turn make *sal* regeneration difficult. It is also clear from these plots that a cessation of annual burning for only 2 years results in reinvasion of evergreens such as *Actinodaphne angustifolia*.

Experimental plots 49-57 laid out in 1931 tend to confirm the above results and also indicate that shrubcutting with burning accelerates the process. Therefore divisional experiments have been begun to see how annual burning on a 50 acre scale will result in regenerating these forests with *sal*.

In Saranda, burning experiments (Exp. plots 2, 9, 10, 11, 12, 13 and 14) are nearing a close. Numerical results will be available next year. Ocular evidence indicates that annual fires in dry *sal* forest definitely hinder *sal* recruitment and existing regeneration. Similarly fires do not seem helpful in moderately dry areas, but may do good in definitely damp places.

In Angul (Exp. plots 3, 4 and 10) it is clear that annual fires for 5 or 6 years in damp forests containing unestablished *sal* will favour the *sal* at the expense of other competitors so that an almost pure crop of *sal* regeneration covers the ground. But cessation of burning allows competitors to re-establish themselves, so that the *sal* seems unable to go ahead without further help from cleanings. Numerical results will be available in 2 or 3 years.

In Angul also a divisional experiment shows that fencing helps *sal* regeneration. This is not so far confirmed in Saranda (from Experimental plots 18-31) where however deer are less common.

(v) *Artificial Regeneration.*

In Kolhan (Exp. plots 13 and 20) it has been shown that propagation of *sabai* grass (*Pollinidium angustifolium*) by rootstocks is easy. Annual weeding and burning is essential. Yields of 25 mds. per acre of dry grass are then possible in poor shaley soil. Erosion does not seem to result. But there are signs that yields per acre tend to fall after 5 or 6 years' annual cropping. This fall in yields is being watched, the experiment has passed into practical divisional work, a plantation of 100 acres being now under formation.

In Kolhan and Palamau work in the year under review indicates that stump planting of teak (*Tectona grandis*) put out in early June is likely to be very successful. This method is now being tried in other divisions such as Angul and Puri where whole transplants were previously used.

In Palamau a most interesting divisional experiment shows great hope of success. The problem is to introduce cheaply a valuable species to replace and supplement the many species of low value in mixed deciduous coppice forest. Eighteen months before fellings were due therefore teak stumps were put out in June 1933 as an underplantation. In January 1934 these stumps had sprouted to an average height of 2' and though somewhat etiolated casualties were very few. It is hoped that after the coppice fellings these teak will take a dominant place in the coppiced crop without expensive cleanings.

In Palamau progress has been made in experimenting with exotics for beautifying the Netarhat plateau (3,500'). Nursery work has been improved and mycorrhiza infected soil ordered from France at the end of the year. In spite of very heavy rain in August 1933 and severe frost in January 1934 *Pinus patula, P. canariensis, Thuja orientalis, Cupressus benthami* and *C. torulosa* show signs of success.

In Angul an interesting experiment of sowing turmeric (*Curcuma longa*) as a catch crop with teak is hopeful. Two plots of ½ acre were planted with turmeric roots in the hot weather of 1933 after burning of slash and subsequent thorough ploughing (5 times). Teak stumps were planted in July. Both looked healthy in November after which the turmeric died back and was covered with leaves.

(vii) *Tending.*

A number of experimental plots in Porahat, Kolhan, Sambalpur East and Puri investigating the intensity and age at which thinnings should be made in *sal* coppice and mixed forest coppice were reorganised and transferred to sample plots.

It is being realised that for *sal* regeneration rains cleanings are essential. Successful results have been obtained by the Divisional Forest Officers, Puri and Kolhan.

(x) *Silvicultural Systems.*

Early burning.—In divisions like Sambalpur East and West and Palamau where grassy blanks and open grassy forest are common some more efficient method of fire protection seems necessary. Early burning in February or March may be successful. Experimental plot 3 in Palamau was laid out during the year to investigate the effect of early burning on regeneration in a grassy blank while the Divisional Forest Officer, Sambalpur West, has also initiated a large scale experiment. Results will not be available for some time.

Bamboo management.—Two experimental plots were laid out, No. 25 in Angul and No. 4 in Sambalpur West by the Assistant to the Silvicul-

turist, Forest Research Institute, Dehra Dun, to investigate the results of various felling systems in *salia* (*Dendrocalamus strictus*). A similar plot will be laid out in 1934-35 in Palamau. These plots will be similar to plots laid out in the Punjab, U. P. and C. P. so that co-ordinated results will be available in 10—15 years time.

Water control.—In July 1933 the Divisional Forest Officer, Kolhan, made a dam and irrigation system in a *nala* that is habitually dry except in heavy rainfall. It is situated in dry Q IV *sal* forest. The object is to see whether by raising the water level by the dam and by distributing surplus water to dry shoulders of land near-by, the quality of the locality can be improved and regeneration stimulated (Experimental plots 22 and 23). The dam certainly seems to raise the water level as water remained behind the dam until mid December whereas it would normally have been dry.

II.—Working Plans and statistics.

(i) *Working Plans.*

The following plans were sanctioned during the year 1933-34 :—

1. Revised working plan for the reserved forests of Sambalpur West division.
2. Revised working plan for the protected forests of Angul division.

The following plans were completed but are still pending Government sanction :—

1. Working plan for the reserved and protected forests of Palamau division.
2. Revised working plan for the reserved forests of Sambalpur East division.

Field work is in progress in connection with the revised working plans for—

1. The reserved forests of Saranda division.
2. The reserved forests of Kolhan division.

The working plans for the Kodarma and Khurchutta protected forests due for revision in 1932 have been extended pending investigation of the policy to be pursued in these forests.

(ii) *Yield and Volume Tables.*

There are 131 standard sample plots in existence in the various forest divisions. Of these 92 are in *sal* forest, 12 in teak, 9 in *Casuarina equise-*

tifolia, 2 in *gamhar* (*Gmelina arborea*), 10 in *asan* (*Terminalia tomentosa*), 5 in *dhaura* (*Anogeissus latifolia*) and one in *karam* (*Adina cordifolia*). Plots were remeasured during the year according to programme.

A 5 per cent enumeration was made in the Girga block of Porahat with the object of checking the volume yield. Advantage was taken to stock-map the area and measure crown spreads with the view of examining the distribution of age classes and crown area occupied by various diameter or age classes. These figures will be worked out in 1934-35.

III.—Miscellaneous.

Photographs.—Arrangements have been made to store all negatives at the Forest Research Institute, Dehra Dun. About 3 dozen photos were taken by the Forest Research Officer during the 1933-34 touring season.

Specific and general ledger files and photos are being maintained under Howard's filing system.

BOMBAY.

I.—Experimental Silviculture.

(i) *General.*

Under the direct control of the Chief Conservator's office there were 11 subjects under investigation during the year while problems of purely local interest were taken up for investigation by the Divisional Forest Officers concerned under the general control of their Conservators.

The work done and observations made are briefly described below :—

(ii) *Natural Regeneration.*

Sandal (*Santalum album*).—At the suggestion of the Silviculturist, Forest Research Institute, Dehra Dun, 100 trees in each of the plots 28A and 28B have been kept under observation for the purpose of confirming the results obtained on the effect of early burning on sandalwood growth and regeneration. Plot 28A has been and will be rigidly fire protected and plot 28B early burnt.

(v) *Artificial Regeneration.*

Rosha grass (*Cymbopogon martinii*).—*Subject No. 12.*—Artificial propagation of *rosha* grass. (West Khandesh division.)

The crop of *rosha* raised on the 7-acre plot was sold for Rs. 51 after blanks had been filled up with fresh tussocks at a cost of Rs. 20. It was not possible to collect separate figures of yield.

Hirda (*Terminalia chebula*).—*Subject No. 13.*—Propagation of *hirda* (Poona and Satara divisions).

With a view to discovering whether *hirda* can be propagated successfully by means of stump planting, 605 stumps were put out in the Poona division in the rains, of which 598 were surviving in January 1934. These are reported to be healthy and to vary between 6" and 10" in height.

(vii) *Tending—Thinnings and Cleanings.*

Subject No. 8.—Increment of *babul* under different degrees of thinning (Hyderabad division, Sind).

In compliance with the advice received from the Silviculturist, Forest Research Institute, Dehra Dun, girth and diameter measurements were recorded again this year.

In the Poona division a plot of 25 acres was originally established to ascertain whether *babul* of suitable size for fuel could not be obtained in areas above flood level within a shorter period than the existing rotation of 40 years. The object was subsequently changed to study the result of heavy thinning as compared with light thinning. With this object in view the plot was divided into two halves, when the crop was 10 years old and about 15 feet high; one half was heavily thinned, the spacing being equivalent approximately to the height of the tree, and the other half lightly thinned.

Remeasurements taken in 1933-34 showed an increase of 89 per cent in total girth (44 trees) under heavy thinning, and 104 per cent (104 trees) under light thinning.

(xi) *Miscellaneous.*

Bahan (*Populus euphratica*).—*Subject No 10.*—(Subsidiary)—To determine the vitality of *bahan* coppice shoots and the number of profitable rotations through which they are able to pass before complete deterioration. (Shikarpur division.)

It having been established that when allowance has been made for differences in soil, degree of inundation and variation of market rates and demands, the economic age for cutting over *bahan* coppice in Upper Sind is approximately 6 years, all the *bahan* sample plots were ordered to be maintained on a 6-year rotation.

So far, plots 10A and 10B have been cut in the 2nd rotation. The Divisional Forest Officer, Shikarpur, has observed that in these two plots a certain amount of lowering of vitality of the stumps has taken place as the yield in the form of rafters is much higher in the lowest class with a considerable fall in yield from the larger sized girth classes.

Sawar (*Bombax malabaricum*).—*Subject No. 33.*—The determination of the rate of increment of *sawar*. (Panch Mahals division.)

In view of the increasing demand in recent years for *sawar* due to the rapid development of the match industry in the Bombay Presidency, an investigation of the rate of growth of this species was started in the year 1929-30 with 20 sound and healthy trees in each of the 6″ girth classes from over 6″ to 48″ girth in two localities, *i.e.*, Block XVII Godhra Range and Block III Halol Range in the Panch Mahals Forest division. The girth of all the trees was measured and four consecutive remeasurements at intervals of one year have been taken, the trees in the several girth classes being reclassified at each remeasurement.

The average annual increment of each girth class obtained at each remeasurement was plotted separately and an even curve drawn for each locality. The mean annual rate of increment derived therefrom is given below :—

Girth classes.	I.	II.	III.	IV.	V.	VI.	VII.	Total.	Average annual increment.
Average girth.	9″.	15″.	21″.	27″.	33″.	39″.	45″.		
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Godhra . .	1·03	1·23	1·25	1·19	1·09	0·90	0·65	7·34	1·05
Halol . .	1·18	1·38	1·42	1·36	1·23	1·00	0·75	8·32	1·19
							TOTAL .		2·24
							Mean average annual increment .		1·12

From the above figures it emerges that the rate of increment of *Bombax malabaricum* steadily rises till the tree reaches an average girth of 21″ after which it gradually declines, but does not fall below the mean average annual increment till a girth of 36″ is exceeded : in other words the economic exploitable age of *Bombax malabaricum* in the Panch Mahals division is (36÷1·12) 30 years in round figures.

Miscellaneous Species.—Subject No. 16.—Effect of improvement fellings on diameter growth. (Dangs, Surat.)

1st and 2nd remeasurements of trees in the two plots were taken in December 1930 and December 1933. The results obtained are given below :—

Plot No.	Total diameter at the original measurement.	DIAMETER INCREMENT.		PERCENTAGE OF INCREMENT.		REMARKS.
		1930.	1933.	1930.	1933.	
	Inches.	Inches.	Inches.	Inches.	Inches.	Improvement felled plot.
16 A	890·61	113·05	96·33	14·1	10·5	
16 B	1334·51	55·84	61·04	4·1	4·3	Control plot.

In the North and West Khandesh divisions, plots containing mixed growth, divided into 2 sub-plots, one control plot and the other subjected to light improvement fellings, are under observation since the year 1928. The remeasurements recorded in 1933 have yielded the following results :—

Division.	Plot.	Area Acres.	Total basal area.		Increase.	Percentage of increase.
			Original measurement 1928.	Remeasurement 1933.		
			Sq. ft.	Sq. ft.	Sq. ft.	
West Khandesh . .	Improvement—Felled . .	2·5	127·47	138·32	16·85	13·2
	Control .	2·5	115·86	127·03	11·17	9·6
North Khandesh .	Improvement—					
	Felled . .	1·0	34·5	41·4	6·9	20·0
	Control .	1·0	45·25	51·74	6·49	14·3

II.—Working Plans and Statistics.

(i) *Working Plans.*

The following working plans were printed and sanctioned during the year :—

(1) Working plan for the Poona Forest division.

(2) Working plan for the Fuel and Fodder Reserves of the Bijapur district.

BURMA.

I.—Experimental Silviculture.

(i) *General.*

Staff.—Mr. R. W. V. Palmer, Deputy Conservator of Forests, was in charge of the division throughout the year.

The subordinate staff consisted of two Range Officers, two Probationary Range Officers, four Deputy Rangers and eight Foresters.

The full programme of work was carried out.

(ii) *Experiments with teak stumps. Project E. XII (a).*

Experimental planting of teak stumps in Lower Burma *taungyas* was started in 1933 at four planting centres.

In Northern Burma stumps are always used but in Lower Burma the method has never been in general use and seed is either sown direct at stake or transplanted from nurseries. The object of the experiment was to find out whether stumps could be used with advantage in Lower Burma *taungyas*.

Planting was done by the research staff inside the *taungya* of the year and under ordinary conditions except that patching blanks was forbidden. Research staff left the area in July and the lines thereafter were tended with the rest of the *taungya*. Food crops were sown as usual. The results at the end of the year were analysed statistically.

The following inferences seem justified for the first year's growth for the particular climatic conditions of 1933 and the centres selected.

Only at Myohla was there partial success from early stumps. More early rain, a lighter soil than elsewhere and the use of two-year old stumps may have contributed to this.

Elsewhere there was not a single survival from 900 stumps, and showers in April which started growth before stumps were lifted, followed by a long dry spell in heavy soil, may be principal causes. Still earlier planting before growth started might have had better results.

Survivals from early planting at Myohla gave better height growth than survivals from middle planting. The latter however were not put in till about 6 days after the rains broke.

Planting at the break of rains gave the best results and casualties were low. Delaying the planting of stumps until mid June reduced or wiped out this advantage and introduced high casualties.

Direct comparisons between diameters are possibly permissible as there were no significant differences between controls and indicate that diameters under one half inch are inferior. Similar comparison between root lengths showed no advantage for the longer roots.

Shoot differences were too small to warrant analysis. As early planting failed, the effect of diameter, root and shoot lengths on early planting cannot be estimated.

The jumper method of planting was cheapest and casualties no higher than for other methods.

Experiments are being repeated.

(iii) *Investigation of the influence of seed origin in the case of teak.*

These experiments which are being carried out in collaboration with the Central Silviculturist were referred to in the Annual Report for

In the following report the letter "E" followed by Roman numerals refers to the project numbers of the Research Programme published on pages 63 to 65 of the Annual Report on Working Plans and Silviculture in Burma for 1926-27.

1931-32 at paragraphs 142-145 and in the Annual Report for 1932-33 at paragraphs 107-112.

Experiments were put down at Pinbaw, Myitkyina division (Upper Burma) in 1931, 1932 and 1933, and at Kunsan, Zigon division (Lower Burma) in 1931 and 1933.

At Pinbaw in 1933, 4,000 seeds each of Myitkyina, Tharrawaddy, Khandesh, Travancore and Nilambur, origin were sown in worked nurseries on 2nd May 1933, half the seed being soaked for 2 days before sowing. Mysore seed arrived late and was sown only on the 2nd June 1933. Germination up to 21st June was best from Nilambur seed (24 per cent), Tharrawaddy seed (12 per cent) and Travancore seed (11 per cent) all others being less than 10 per cent.

Seedlings were transplanted to stake in lines of 100 each as soon as available. Height measurement on 11th March 1934 gave best results from Tharrawaddy (37 per cent over 2') Travancore (30 per cent over 2') and Nilambur (29 per cent over 2').

Quarter to half acre plots were formed from seed from 4 sources giving sufficient germination up to end of June and measurements on 12th March 1934 placed growth in following order—Nilambur, Travancore, Myitkyina, Tharrawaddy.

At Kunsan in 1933 from similar sowings and dates germination up to 21st June was Nilambur (36 per cent) Tharrawaddy (35 per cent) Travancore (27 per cent) and Zigon (17 per cent).

Height measurement of first 100 seedlings transplanted to stake gave on 5th December 1933 the best results from Nilambur, Travancore and Myitkyina each of which had 24 per cent over 2 feet.

Half acre plots formed from seed from 5 sources giving sufficient germination up to beginning of July were measured on 7th December 1933 and growth placed in the following order—Travancore, Nilambur, Tharrawaddy; Zigon, Mysore.

Remeasurement of the larger Pinbaw 1931 series of plots (E. P. 12 see paragraph 145, Annual Report for 1931-32 for particulars of germination) in March 1934 after 3 years growth gave average heights of survivals as below :—

Origin of seed.	Percentage survival.	Average height survivals (feet).	Remarks.
Kanara . . .	46	7·9	The order is the same as after 2 years growth when average heights survivals were— Kanara . . 3′ 6″ Travancore . . 8′ 4″ Myitkyina . . 4′ 9″
Travancore . . .	73	13·2	
Myitkyina . . .	78	10·6	

The low percentage survival is attributed to insufficient weeding.

Remeasurement of the 1932 Pinbaw series of plots (E. P. 13, see paragraph 110-112 Annual Report for 1932-33 for particulars of germination and transplanting) in March 1934 after 2 years growth gave the following result :—

Origin of seed.	Percentage survival.	Average height survivals (feet).	Remarks.
Nilambur . . .	85	8·5	The order after one year growth was— Travancore . . 2·3′ Myitkyina . . 1·9′ Nilambur . . 1·8′ Tharrawaddy . 1·8′ Kanara . . 1·1′ Khandesh . . 0·9′ Nilambur has gone ahead from Tharrawaddy and Myitkyina.
Travancore . . .	85	9·1	
Khandesh . . .	74	5·1	
Tharrawaddy . .	90	7·6	
Kanara . . .	84	6·9	
Myitkyina . . .	91	7·5	

Remeasurement of the 1931 Kunsan plot (E. P. 8, see Annual Report 1931-32 paragraph 144 and 1932-33 paragraph 109) in December 1933 after 3 years growth gave the following results :—

Origin of seed.	Percentage survival.	Average height survivals (feet).	Remarks.
Nilambur . . .	88	12·6	Local Zigon seed showed poorest growth after 2 years has now caught up and passed all except Nilambur.
Travancore . . .	78	11·0	
Zigon	88	12·3	
Kanara . . .	86	8·8	
Myitkyina . . .	89	9·6	

Lateness of seed arriving and quality of seed has affected results, but Nilambur and Travancore seed seem best suited and give good early growth.

At this stage plants from Indian origins are markedly different in leaf shape from Burma teak.

II.—Working Plans and Statistics.

(i) *Working Plans.*

Field work and Area.—As the finances of the Province have not yet improved all working plans field work was again suspended. This is, as stated in last year's report, regrettable as not only does it entail arrears in the preparation of working plans but also the disorganization of the highly trained working plans parties.

Following a conference in September 1933 Mr. M. N. Gallant, Deputy Conservator of Forests, was posted to special duty in January 1934 to examine the question of fixation of yields in all current working plans. The work entails examination of stocks as estimated by enumeration parties, numbers of trees found and left during girdling, etc., etc., and will take a considerable time to complete.

Compilation.—During the year under report a revised plan for 98 sq. miles was sanctioned as against new plans for 1,729 sq. miles and revised plans for 807 sq. miles in the preceding year.

The position as regards working plans at the close of the year under report as compared with that at the close of 1920-21 when the Working Plans Circle was formed is shown below. For the purpose of comparison figures for the Federated Shan States are included :—

	1920-21.	1933-34.
	Sq. miles.	Sq. miles.
Area under sanctioned Working Plans . . .	10,855	26,360
Area for which plans are under preparation . .	328	1,230
Area for which plans are required	8,236	1,320
Total .	19,419	28,910

Control.—The prescriptions of existing working plans were generally followed according to the availability of funds and the state of the timber market. Practically all works are in arrears owing to the lack of demand in the case of marking of hardwoods and lack of funds in the case of improvement fellings, roads, buildings and other forest works.

The following statement shows teak girdlings carried out in recent years :—

1		In Reserves. 2	Outside 3	Total. 4
Average annual girdlings, 1920-25		151,262	69,410	220,672
Ditto 1925-30		140,842	74,299	215,141
1930-31	Burma	125,277	101,981	227,258
	Federated Shan States	9,385	15,308	24,693
	TOTAL	134,662	117,289	251,951
1931-32	Burma	138,690	75,211	213,901
	Federated Shan States	13,130	4,762	17,892
	TOTAL	151,820	79,973	231,793
1932-33	Burma	80,903	38,833	119,736
	Federated Shan States	9,888	9,018	18,906
	TOTAL	90,791	47,851	138,642

Preliminary Working Plan Reports.—Zigon division.—A preliminary working plan report which lays down the main lines on which the revision of the working plan should be carried out was drawn up by Mr. H. R. Blanford, O.B.E., Conservator of Forests, in 1930-31.

Arakan division.—A preliminary working plan report was submitted by the Divisional Forest Officer during the year.

Temporary Working Plans and Programmes.—Practically all works under temporary plans such as road and building schemes, etc., are in arrears owing to lack of funds.

The following temporary plans have already lapsed or will lapse during the next three years :—

Circle. 1	Division. 2	Name of Plan. 3	Year of lapse. 4	REMARKS. 5
Hlaing-Delta	Prome	Building scheme	1934-35	Incorporated in Divisional plan under preparation.
		Road scheme	1934-35	
	Delta	Building scheme	1932-33	Do.
Sittang-Tenasserim.	Shwegyin	Paddy Field girdling scheme.	1931-32	Do.
	Thaton	Do.	1931-32	
	Salween	Do.	1932-33	
	Thaungyin	Do.	1931-32	
	Do.	Plan for thinning and cleaning.	1933-34	

Circle.	Division.	Name of Plan.	Year of lapse.	REMARKS.
1	2	3	4	5
Northern .	Mansi . .	Paddy Field girdling scheme.	1929-30	Can carry on until Divisional Working Plan is prepared.
	Do. . .	Plan for thinning and cleaning.	1932-33	New scheme will shortly be sanctioned.
	Kaukkwe . .	Road scheme .	1931-32	Incorporated in Divisional Working Plan under preparation.
		Building scheme .	1931-32	
		Plan for repairing interior boundaries of reserves.	1933-34	
Chindwin . .	Myittha . .	Road scheme .	1932-33	
Federated Shan States.	Mongmit . .	Improvement Felling scheme.	1931-32	Will be incorporated in Divisional Working Plan under preparation.
		Building scheme .	1934-35	

Acclimatisation.—(*Ornamental*).—The garden has always led the way in this branch, especially with ornamental plants. The work carried out has been recognised abroad, so much so, that one of the leading seed houses in England, Edward Webb & Sons of Stourbridge, sent out a selection of annual seeds of new strains for trial and report. The collection included *Abronia*; *Agatheae*; *Alonzoa*; *Collinsia*; *Collomia*; *Cynoglossum*; *Diascia*; *Downingia*; *Erysimum*; *Eutoca*; *Jacobea*; *Matricaria*; *Perilla* and *Sanvitalia*. Most of the above show great promise and if successful will add to our already large selection of flowering annuals.

Other new introductions included *Pentstemon;* Sweet William; Michaelmas Daisy; *Rudbeckia* and *Echium.*

Of the perennials and other hard wooded plants presented to the garden last year by Mr. C. G. Kay-Mouat, O.B.E., the *Tradescantia* failed entirely. The Delphiniums seeded well and several new varieties are in the process of being acclimatised. The Torch Lily, Double Violets and Perennial Phlox flowered profusely and are well established. Broom and Solidago failed to do anything. Buddleias and *Acer variegata* have been put out in permanent quarters.

(*Economical*).—Six plants of a new apple, Rome Beauty, were received for trial. This has a big reputation in Bangalore and other parts of Mysore State; fruiting very profusely with very little attention. It is hoped it may prove a success in Maymyo.

Propagation of other fruit bearing plants was done on a small scale and older parent plants were just maintained in a living condition. Propagation methods as reported upon last year proved a success so that in future all our pears and apples will be increased by this method.

General.—New Sample Plots were formed during the year as below :—

S. II. Volume increment per acre. Teak	*Nil.*
S. III. Volume increment per acre. Other species . .	8
S. IV. Girth and diameter increment of individual trees. .	6

The following existing sample plots were remeasured :—

S. II. Volume increment per acre. Teak	100
S. III. Volume increment per acre. Other species . .	12
S. IV. Diameter and girth increment of individual trees. .	14

(ii) *Yield Tables.*

S. X. Outturn Volume Tables for teak from figures supplied by the principal teak firms down to 1932 were sent to the Press during the year for publication as Burma Forest Bulletin No. 31 (Silvicultural Series No. 15). The Bulletin contains 97 tables from the principal teak forests in Burma, outturn volume being given by three inch girth and one inch diameter classes.

(iii) *Heritiera fomes vel minor* (*Pinle-kanazo*).

Nine new plots principally for girth and diameter increment of individual trees were formed in the Irrawaddy Delta for *Heritiera minor*. Of these nine plots, four were originally Divisional Plots formed in 1928 for girth increment in dense natural unworked almost pure crops of *Heritiera* at various levels. Such *Heritiera* crops contain trees of all diameters.

On taking over these plots the girths in 1934 were measured in addition to diameters, and increment and age/girth curves drawn for the 6-year period. The minimum girth of trees measured was 12″ at 8′ 6″ and the age to minimum girth estimated by prolonging the curve backwards.

Attempts to estimate the age to 12″ girth by counting rings has been so far unsuccessful as rings are extremely difficult to count. The age to 12″ girth is therefore mainly guess work but such countings as have been possible indicate that it is not far out.

It should be noted also that these measurements are all in untouched probably over-stocked crops specially selected in areas where little or

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As in the previous Section the abbreviations used, *i.e.*, S. V. refer to the project numbers of the Research Programme published at pages 63 to 65 and 73 of the Annual Report on Working Plans and Silviculture in Burma 1926-27.

no extraction has taken place and where the increment put on may be expected to be slow.

Sample Plots Number.	Type of Forest.	No. of trees used.	Apparent age to girths at 8′ 6″.				
			1′.	2′.	3′.	4′.	5′.
3	Low Intermediate level .	143	106	205	280	322	374
4	„ .	160	106	186	240	276	310
5	„ .	195	100	174	226	262	302
6	„ .	170	100	190	266	318	348

Only trees classified as suppressed and showing no increment, dead trees and a few trees showing unreasonably large increments likely to be due to mistakes in measurement were excluded from the calculation.

Rough averages for all plots for the time taken to pass through these girth classes together with the percentage of trees in each girth class and the percentage classified as dominant trees at the time of measurement are given below :—

	Girth classes.				
	0′-1′.	1′-2′.	2′-3′.	3′-4′.	4′-5′.
Approximate years taken .	100	90	60	40	40
Percentage of total stocking	..	36	29	17	18 (4′ & over).
Percentage dominant .	..	10	61	95	100

Girth is put on at a progressively increasing rate till 4′ is reached and then remains steady. Actually the rate begins to fall from about 4′ 6″. The tree takes its place as a dominant tree in the upper story by the time it has reached 3′ girth. Actually 75 per cent trees over 2′ 6″ were classed as dominant.

The five new plots formed are in areas opened up by extraction to varying degrees. Three of them are in areas worked out for the Rangoon fire-wood supply on a four foot girth limit.

More rapid growth to four foot may reasonably be expected when these plots are re-measured.

Heritiera is at present worked almost entirely as fire-wood, the minimum girth at 8′ 6″ being fixed at 4 feet.

(iv) *Match wood species.*

Paragraphs 160 and 162 of this report for 1931-32 gave average annual girth increment for a number of species in tree increment sample plots in Insein division. Further measurements have been taken and all

available figures to 1934 used. Increment and girth/time curves were worked out for three important matchwood species. The results are as below : —

Species.	Type of forest.	No. of measurements.	Years taken to pass through 6" breast height girth classes.								
			18" to 24".	24" to 30".	30" to 36".	36" to 42".	42" to 48".	48" to 54".	54" to 60".	60" to 66".	66" to 72".
Sterculia campanulata.	Lower Mixed Deciduous.	56	..	11	12	10	6	6	..	..	..
Ditto .	Moist Upper Mixed Deciduous.	26	..	..	..	26	12	33	..	..	..
Ditto .	Evergreen . .	180	7	9	11	11	15	18	..	..	..
Bombax insigne .	Lower Mixed Deciduous.	43	..	9	8	8	6	7	..	..	..
Ditto .	Moist Upper Mixed Deciduous.	29	38	32	29	25	21	17	..	..	..
Anthrocephalus cadamba.	Evergreen . .	25	..	15	14	10	7	5	.	5	4

The growth of *Bombax insigne* in moist upper mixed deciduous forest is noticeably slow and may in part be due to poor quality forest.

(v) *Shrinkage of teak after girdling.*

S. V. Paragraph 164 of this report for 1931-32 and paragraph 120 of the report for 1932-33 gave particulars of the progressive shrinkage of trees girdled in the Prome plantation of 1858 in February 1931 for periods of 2 months, one year and two years after girdling, measurements being made to the nearest ·1 of an inch with a steel tape.

These figures indicated that reduction in girth of about ·6" for trees under 4' 6" girth at breast height and ·8 inches for trees between 4' 6" and 6' 6" might be expected by April in the case of trees girdled in February. Similarly one year after girdling reduction of 1 inch and of 1·25 inches might be expected. As in practice girths at girdling are measured to the nearest inch, remeasurement to the same standard of accuracy should not show a reduction of more than one inch in the first instance and two inches in the second for trees up to 6' 6" girth. Differences would be greater with larger girths and for trees girdled in November, and subsequently re-measured during the next and the following hot weathers, February being the month in which trees have the lowest heart-wood moisture content, *vide* " A note on the Seasoning of Burmese Timbers by L. V. Teesdale, 1924 ".

A final set of measurements were made at 4' 10", three years after girdling, and it was found that there was no further reduction. Shrinkage was therefore complete two years after the death of the tree.

Figures for total shrinkage are given below and may be of use in assessing the addition to be made to bark thickness figures to allow for timber shrinkage in the case of trees measured dry under bark ;—

Girth class green over bark at 4' 10".	No. of trees.	Mean tree of girth class	Reduction in girth due to loss of bark, inches.	Reduction in girth due to timber shrinkage, inches.	Total reduction, inches.
3' to 3' 6" . . .	21	38·2	2·38	·23	2·31
3' 6" to 4' . . .	24	44·8	2·59	·24	2·83
4' to 4' 6" . . .	25	51·4	2·53	·28	2·84
4' 6" to 5' . . .	21	57·8	2·85	·28	3·13
5' to 5' 6" . . .	16	62·3	2·79	·32	3·11
5' 6" to 6' . . .	14	67·9	2·90	·38	3·32
6' to 6' 6" . . .	10	73·4	2·92	·39	3·31

CENTRAL PROVINCES AND BERAR.

I.—Experimental Silviculture.

(i) *General.*

A triennial programme of Silvicultural Research for the years 1933-36 was prepared during the year and submitted to Dehra Dun for approval.

During the past year the Silviculturist has carried out the routine measurements of a large number of sample plots, he has laid out new sample plots in young regenerated forests and has organised two major experiments, dealing with the grazing problem in the Yeotmal division and the working of bamboos in the Balaghat division.

In the large and scattered divisions of the Central Provinces, the Provincial Silviculturist can superintend only a few major experiments in addition to the statistical work over which he must necessarily exercise control. Satisfactory experimental work can only be carried out by Divisional Forest Officers under the instructions and directions of the Silviculturist.

Experimental Plots.—There were 27 experimental plots on the provincial list at the beginning of the year. 19 of these plots were visited by the Silviculturist and seven were abolished on his recommendation, while one plot was added. The total number of experimental plots is now 21, which are distributed as follows : —

Eastern Circle	1
Central Circle	14
Western Circle	6
Total .	21

Distribution by species is as follows :—

Teak (*Tectona grandis*)	15
Sal (*Shorea robusta*)	1
Rohan (*Soymida febrifuga*)	3
Miscellaneous	2
TOTAL	21

During the year the Silviculturist also selected and laid out 165 square-chain grass plots in the Yeotmal division, in which detailed weighments and observations will be made annually for a number of years to ascertain the effect on the pasture of various closures and grazing incidences.

For the All-India bamboo investigations, a series of plots was laid out in the bamboo forests of the Balaghat division by the Assistant to the Silviculturist, Dehra Dun, in consultation with the Provincial Silviculturist, to study the comparative results of felling cycles of 3, 4 or 5 years and of the retention of various numbers or proportions of culms.

(ii) *Natural Regeneration including coppicing, root suckers, etc.*

The adoption of systems of conversion or of coppice in place of the selection and improvement systems previously largely practised in the Central Provinces has made it necessary to study more carefully the conditions influencing natural regeneration and coppice.

While the results of the new systems have generally been satisfactory, because of the prolific coppicing powers of most of our important species, particularly of teak, the results in the most valuable teak forests have not been so satisfactory. It is in forests of this nature, where heavy rainfall, rich soil and an absence of grazing encourage a rank growth of grass or of bamboos, that the regeneration of teak is most scanty and least able to establish itself. Thus in the Bori forests of Hoshangabad, regeneration is far from satisfactory and it may be necessary to revise the plan or to adopt artificial methods of regeneration. In the valuable Allapilli teak forests, the results of clear felling have been so disastrous that artificial regeneration has now been introduced over large areas, while in North Chanda, the treatment of the rank growth of dense bamboos of poor quality has presented such a difficult problem that a drastic revision of the plan is contemplated. It is now evident that dense bamboos or a rank growth of grass make natural regeneration of teak almost impossible and that teak regeneration is usually most abundant in forests where the overwood contains a large admixture of miscellaneous species giving shade sufficient to reduce the growth of grass.

(iii) *Seeds (Collection, weight, germination per cent., plant per cent., aids to germination, etc., etc.).*

Sal.—The abnormally heavy early rains of May and June 1933 resulted in an exceptionally favourable seed year for *sal* (*Shorea robusta*) and several *sal* divisions report that it was the best seed year in living memory. In the cold weather *sal* seedlings were almost everywhere abundant. To determine how many seedlings eventually survive, a number of observation plots have been laid out in several divisions : in these plots the seedlings will be counted periodically and their height growth recorded and the data thus collected will show to what extent a really prolific seed year can be relied on to assist regeneration.

Teak.—Teak seeded normally in most divisions but where the attack of the teak defoliator (*Pyrausta machaeralis*) was severe, no seed was produced.

Bamboo.—Dendrocalamus strictus seeded sporadically in several divisions. *Bambusa arundinacea* flowered gregariously in the plantations raised at Yeota in 1887 in the West Berar division.

The Silviculturist again acted as an agent for the supply or exchange of seed, both inside and outside the province.

(iv) *Nursery Work.*

The office of the Silviculturist was moved to Nagpur during the year and the experimental nurseries in his charge at Betul have been abandoned. No suitable site for an experimental nursery in Nagpur has yet been found.

Nurseries were maintained in several divisions for agri-silviculture and plantations.

In the Yeotmal division, teak seed was treated by burying in a white ant hill for a fortnight and by soaking for 2 days in a pit filled with water and cow-dung, and then drying in the sun for 3 days. The latter treatment gave a higher percentage of germination. It was also successful in Nagpur-Wardha.

The *dona* or leaf cup system was again employed in the Bilaspur teak nurseries and continued to give highly satisfactory results.

(v) *Artificial Regeneration, including taungya.*

In the Bilaspur division, the Tenduchua teak plantations were extended by 27 acres. In Coupe No. 5, an area of 19 acres was planted with teak and *shisham* in the ratio of 2 : 1, at a cost of Rs. 12 per acre

including the cost of four weedings. The following statement shows the results of the operation :—

Species.	No. of plants used.	No. of plants living on 1-3-34.	Casualties.	Percentage of casualties.	Maximum height.	Average height.
Teak . . .	12,333	11,938	395	3·2	7·0′	8″
Shisham . . .	6,167	5,965	202	3·2	3·5′	12″

In Compartment No. 311 in the same division, an area of 8 acres was planted, teak and *shisham dona* plants being used in equal proportions. As the plantation was on a steep slope, small semi-circular trenches were dug above the plants to prevent erosion. The average cost, including one weeding in November, was Rs. 14 per acre.

The All-India Teak Origin Experimental Plantations in the Bilaspur division which were laid out in June 1931 were visited by the Silviculturist during the year. The set of 6 plots on gneiss are in good condition and well stocked : three of the six plots on schist are unsatisfactory, being on low-lying ground unsuitable for the experiment. Cleanings and thinnings are now necessary in all the plots and a set of sample plots will be laid out in them during the season 1934-35.

The following statements show the maximum and average height and girth of the trees in each plot in June 1934 :—

Schist Plots.		Age 3 years.			
		Height in feet.		Girth in inches.	
No.	Origin.	Maximum.	Average.	Maximum.	Average.
1	Nilambur . . .	25	21	11	8
2	Tenduchua, C. P. . .	24	17	10	6
3	Kankankoti, Mysore .	23	16	10	7
4	Kanara, Bombay . .	22	15	9	6
5	Myitkyina, Burma .	17	11	7	4
6	Betul, C. P. . .	21	..	7	..

In this set of plots, No. 6 is a failure and Nos. 4 and 5 are unsatisfactory.

Gneiss Plots.		Age 3 years.			
		Height in feet.		Girth in inches.	
No.	Origin.	Maximum.	Average.	Maximum.	Average.
1	Kankankoti, Mysore .	26	17	10	8
2	Nilambur . . .	24	17	11	7
3	Kanara, Bombay . .	22	15	12	7
4	Tenduchua, C. P. . .	22	13	10	6
5	Betul, C. P. . . .	23	12	10	6
6	Myitkyina, Burma .	20	11	9	6

The growth in the Burma plot is rather unsatisfactory.

The plantations of Mysore and Nilambur origin are at present the most promising in both sets of plots and the Betul and Burma plots are the poorest.

Natural regeneration in the coupes of the plains felling series of South Chanda was not as successful as expected. It was therefore decided to regenerate the current year's coupe artificially. The forest consists of an overwood mostly of teak with a dense undergrowth of bamboos. An area of 180 acres was practically clear felled and the very heavy debris was burnt. As no nurseries had been made, the technique had to be improvised. A spacing of 12′ by 12′ was adopted, as the growth of bamboo was expected to cover the ground sufficiently. About 6,000 root and shoot cuttings were obtained from natural seedings in the adjoining forest. The rest of the area was dibbled and filled with *dona* (leaf cup) plants. It is too early to report on the success of the operations, but the cuttings appear to have succeeded. The *donas* were small and were put in late and success is doubtful. Some of the bamboos have been killed by fire but on the whole regrowth is good and will cover the ground. Other weeds and grass gave little trouble. The *kawich* (*Mucuna pruriens*) climber was common and was pulled up by the roots. It was noticed that where the ground was clean, the growth of teak seedlings was prolonged to December and January. The divisional forest officer attributes this to the free access of dew to the ground around the teak plants.

Agri-silviculture was continued in West Berar, Nimar and Amraoti but owing to the continued cotton slump was not popular. In Berar, the attacks of the *babul* borer (*Coelosterna scabrata*) are so severe, that this species (*Acacia arabica*) is no longer considered suitable for plantations and *khamar* (*Gmelina arborea*) and *nim* (*Melia indica*) are now used instead.

In the Melghat division, it is evident that *Lantana* infested areas can be satisfactorily regenerated only artificially. The Divisional Forest Officer is now making experiments to ascertain the most suitable methods. Where the overwood has been destroyed by fierce fires in the *Lantana*, it is probable that after clear felling and burning it will be necessary to sow field crops for two successive years in order to destroy the *Lantana*, and subsequently to plant tree species in weeded strips 12 feet apart. Where the overwood has not been destroyed by *Lantana* fires, it is hoped that sowing of field crops will not be necessary but that planting of teak on weeded lines will succeed. Deer are causing serious damage in this division and fencing of regeneration areas will probably be necessary.

(vii) *Tending—Thinnings, Cleanings, Climber and Weeds.*

Nine years have now elapsed since the earliest conversion plans were introduced in the Central Provinces: thinnings and cleanings are now

becoming urgent in the coupes first converted and the silvicultural treatment of these areas will become a matter of ever increasing importance in the next few years. We have as yet little experience of the treatment required and in the coming year experimental plots will be laid out in a number of divisions to determine when the first cleaning should be done, the intensity of the thinnings required and the need for thinning out multiple stems in young teak coppice. Eight sample plots have recently been laid out by the Silviculturist in young teak and *sal* forests and the progress of growth in these should give some indication of the silvicultural treatment required.

Several officers now deprecate the ruthless cutting out of *salai* (*Boswellia serata*) in thinnings in teak forest; they have observed that in open areas this tree serves as a nurse and a centre around which teak seedlings often succeed in establishing themselves.

An exceptional case in which heavy fellings are perhaps justifiable in areas not yet under conversion is in places where groups of teak reproduction and advance growth are found spreading under cover of a miscellaneous forest. In order to encourage the teak and thus to enhance the value of the forest when its time for conversion comes, several plans now allow clear felling of the overwood over such groups of regeneration, together with the cutting back of the teak. There is, of course, a danger that regeneration operations of this nature in periodic blocks not under conversion may lead to over-felling; but areas suitable for such treatment are generally very limited and provided no immature teak is sacrificed the risk of overfellings is not great.

Weeds.—Mahul (*Bauhinia vahlii*). This is probably the most generally harmful climber: in parts of the Betul division it is so profuse that in certain coppice felling series clear fellings have had to be abandoned as they encourage its growth, light improvement fellings substituted, and a special climber cutting programme prescribed. This climber is causing similar apprehension in Nagpur-Wardha.

Lantana (*Lantana camara*) continues to cause alarm in numerous localities. On the Pachmarhi plateau it has now been almost eradicated but it is reported in other parts of the Hoshangabad division. In Betul, many *malguzari* areas were becoming over-run with *Lantana* and to prevent its spread into Government forest, special eradication measures were undertaken, 261,000 bushes being uprooted at a cost of Rs. 330. The divisional elephant gave valuable assistance. Similarly in Chikalda a herd of elephants continued to help in the campaign. This shrub is reported to be spreading in parts of the Mandla division and the co-operation of malguzars has been enlisted against it. It appears that seed is washed down in floods and the banks of large rivers are therefore dangerous lines of infection.

Petalidium barlerioides.—This weed has proved a serious obstacle to teak regeneration in South Chanda and elephants have been employed to eradicate it.

Kawich (*Mucuna pruriens*).—This climber has spread prolifically in regeneration coupes in South Chanda. If eradication is necessary, the work will have to be done before the fruit forms in December, when the itch becomes so intense that coolies cannot work in an infested area.

Cassia tora (*Tarota*).—This weed is very prejudicial to the growth of valuable fodder grasses, especially in heavily grazed areas in Nimar. The cost of weeding is prohibitive and periodical closure to grazing is the only practical remedy.

(viii) *Mixtures.*

The need for retaining a mixture of shade-giving trees of miscellaneous species in the dry teak forests of the Central Provinces is yearly becoming more evident, and has been especially emphasized in recent years by the stimulus given to teak by the clear fellings now commonly practised. Teak is perhaps the most vigorous coppicer of the commoner trees in our forests and clear felling is therefore more favourable to it than to poorer coppicers which are at the same time usually more liable to damage by browsing. Clear felling thus greatly increases the proportion of teak in a coupe.

Pure teak crops are very undesirable in the dry forests of the Central Provinces. Teak sheds its leaves much earlier, and is a much more insistent light demander and of much less leafy habit in the Central Provinces than in Burma or South India. In consequence, it provides very little cover for the soil with the result that a dense undergrowth of grass or bamboos is generally found in teak forests in which there is little grazing or where there is no mixture of shade bearing trees which retain their foliage in the hot weather. Teak regeneration establishes itself with difficulty in grassy areas and consequently is always much more abundant in forests containing miscellaneous species than under the open canopy of a more or less pure teak forest. Other disadvantages of growing teak pure are that pests like the teak defoliator are much more dangerous in pure forest, and that the excessive exposure under the open canopy is likely to result in denudation or soil deterioration.

It has been suggested that at the first cleaning and thinning ten years after the main fellings, miscellaneous species should be favoured against the teak. Miscellaneous species being poorer coppicers than teak, slower growers and more liable to damage from browsing are invariably at a disadvantage under a clear felling system. For this reason, under the coppice with reserves system which is now generally favoured for the

teak forests of these provinces, special prescriptions are introduced for the reservation of poles and advance growth of suitable miscellaneous species.

(xi) *Miscellaneous, including fire, grazing.*

(*a*) *Grazing.*—For the purposes of grazing control, the Local Government has ordered a reclassification of all forest lands according to the relative importance in each area of the production of timber and fuel on the one hand and the satisfaction of the grazing demand on the other. The reclassification into types and the grazing incidence permitted in each type are as follows :—

A. *Tree forests,*—in which the production of trees is the primary object of management and grazing restrictions will be regulated by the silvicultural requirements of the forest.

(i) Moist type—over 45 inches annual rainfall. Incidence permitted 4 acres per head.

(ii) Dry type—under 45 inches annual rainfall. Incidence permitted 3 acres per head.

B. *Scrub forests,*—in which the preservation and improvement of the pasture are the primary objects of management. Here the grazing restrictions should have the preservation and improvement of the pasture as their chief object.

(i) *Pasture forests.*—Incidence permitted 1 acre per head.

(ii) *Open pastures.*—No restrictions of incidence : rotational closures to be arranged for.

In accordance with these orders, the forests of all divisions have now been reclassified and in all future grazing settlements, grazing restrictions and closures will be prescribed on the lines now ordered by Government.

Government have at the same time directed that the experimental investigation into grazing incidences and the effect of various closures on the quality of the pasture should be continued. As the experimental plots laid out in previous years had failed to give any results, the Imperial Silviculturist was consulted in the matter and he kindly drew up a revised scheme for conducting the investigation. In accordance with his suggestions, the provincial silviculturist personally selected and laid out 165 square chain experimental grazing plots in the Yeotmal division. The grass yield on these plots is to be carefully recorded for at least five years by which time it is hoped that it may be possible to draw definite conclusions. The Chief Conservator has directed that similar plots be laid out in several other divisions, where the experiments will be carried out under the supervision of divisional forest officers.

In accordance with Government orders, a scheme of rotational closures has been provided for in the Nagpur-Wardha working plan.

In the Jubbulpore division, bamboo regeneration suffered severely from browsing in areas where bamboos flowered gregariously in recent years. Special provisions should be made in working plans to close to grazing areas in which gregarious bamboo flowering occurs.

(*b*) *Frost.*—Exceptionally severe frosts occurred in many parts of the Central Provinces between the middle of January and the first week in February and very serious damage, particularly in coppice coupes, is reported from many divisions, notably Nimar, Betul, Hoshangabad, Balaghat and Jubbulpore. In consequence, clear fellings have now been abandoned in certain felling series in Betul and in Hoshangabad, while in the Jubbulpore division a strip system is being introduced experimentally in certain *sal* high forest felling series. *Sal* coppice and saplings have escaped on the west side of clumps of bamboos, groups of trees or even big boulders but in exposed places, everything has been killed back. In the Betul division, the hilly nature of the country affords protection from the morning sun and thus greatly lessens the frost danger.

(*c*) *Fire.*—The constant heavy early rains between April and June 1933 made conditions very favourable for fire protection and few serious forest fires occurred during the year. To lessen the danger from fire, Conservators are empowered to open clear felled coupes to grazing, limited if necessary, as soon as the coppice and regeneration are sufficiently well established to be out of danger from browsing.

The Khandesh system of protective burning has been tried in several divisions but several officers report unfavourably on the results and prefer the ordinary system of protective burning which is permissible in General Protection areas under the fire protection rules.

In the Saugor division, to reduce expenditure on fire protection, coupes closed for five years and more were opened to cows and bulls only from 1st October, 1933, *i.e.*, after the Monsoon. The cattle however would not readily eat the grass, which is coarse by October, and the experiment failed in its object.

II.—Working Plans and Statistics.

(i) *Working Plans.*

Nimar, South Mandla and Bilaspur.—Printed copies of these plans were received from the press and were issued during the year.

North Mandla.—The first draft of the plan for the old North Mandla division required certain modifications. A revised draft was prepared by Mr. Gentle and submitted to the Chief Conservator.

Saugor and Nagpur-Wardha.—These two plans were completed during the year: the Saugor plan has been submitted to the Local Government for sanction, and the Nagpur-Wardha plan has been submitted to the Chief Conservator.

Betul, Melghat.—The field work for the Betul plan was completed by Mr. Gurdial Singh who is now preparing the plan. The field work for the Melghat plan was started by Mr. Stein: this important plan will take two years to finish.

Amendments and revisions.—The revision of the plan for the Raipur *Sal* forests was completed by Mr. Stein and received the sanction of the Local Government. To bring the Balaghat Mixed forest plan up to date, Part II of the plan has been largely redrafted by the Silviculturist in consultation with the divisional forest officer. The teak forests of the Pandhratola block were stock-mapped by Mr. S. S. Ahmed.

Many minor amendments to plans were issued. The more important were amendments to the Bilaspur and Bhandara plans under which *garari* (*Cleistanthus collinus*) will be worked under a longer rotation, measurements in coppice coupes and in sample plots having shown that the rate of growth is considerably slower than was believed.

During the past ten years, working plans have been revised or prepared or are in course of preparation for all divisions except Damoh, West Berar, Yeotmal, South Chanda (part), Amraoti (part).

Most of the new plans are working satisfactorily except the North Chanda plan where only partial stock-mapping was done. The chief defect of this plan is that large areas of mixed forest with dense bamboos were included in simple coppice or conversion felling series. The result of clear felling has been that the trees have largely failed to coppice and only the underwood of bamboos now remains.

A feature of the more recent plans has been the introduction of a system which, in the absence of any recognised silvicultural term, has been called the system of Coppice with Reserves. Large areas of forest in most divisions carry a poor type of forest which is only capable of producing small poles and fire-wood, the produce actually most in demand. Interspersed in the forests of this type, and often forming a patch-work in one and the same compartment, are found other types which for various reasons demand special silvicultural treatment. Thus in favourable localities, the quality both of the teak and of the mixed forest is distinctly higher than that of the rest of the forest and clear felling on a short rotation would involve the needless sacrifice of much immature timber; here economy demands that well-grown poles be reserved to form part of the future crop. Other types are forests in which teak is tending to become pure, where the reservation of poles of

miscellaneous species is desirable, and open understocked areas or localities liable to frost in which the retention of an overwood is essential. The systems of simple coppice and of coppice with standards are too rigid for the varying silvicultural requirements of forests of such differing types. A composite form of treatment is needed under which each area can be treated in accordance with its own silvicultural character. The treatment may thus vary from clear felling in well-stocked areas of poor quality to a light thinning in groups of good quality teak poles. Such a system cannot correctly be termed coppice with standards which would imply the reservation of standards equally distributed throughout a coupe. In these forests much more elastic prescriptions are needed. In the absence of a recognised name for such a system it is necessary to invent a new term and the name " Coppice with Reserves " has therefore been adopted. The chief objects of management in forests treated in this way will be the supply of poles and fuel in the poorer quality areas, and of medium sized timber in the better localities, while in understocked forests and in areas over-run with climber or liable to frost, protection must be the primary consideration.

(ii) *Yield, Volume, and Form Factor Tables.*

Sample plots.—There were 86 sample plots on the provincial list at the beginning of the year, and eight new plots were laid out by the Silviculturist during the year, 5 in teak plantations in the Bilaspur and Raipur divisions and 3 in regenerated *sal* areas in the Raipur division. The distribution of the 94 plots is as follows :—

Eastern Circle	60
Central Circle	19
Western Circle	15
TOTAL	94

The distribution by species is given below :—

Teak (*Tectona grandis*)	42
Sal (*Shorea robusta*)	41
Saj (*Terminalia tomentosa*)	1
Chir pine (*Pinus longifolia*)	2
Bija (*Pterocarpus marsupium*)	1
Garari (*Cleistanthus collinus*)	2
Babul (*Acacia arabica*)	1
Anjan (*Hardwickia binata*)	1
Bhirra (*Chloroxylon swietenia*)	1
Miscellaneous species	2
TOTAL	94

In addition to the 8 new plots, full measurements were made by the Silviculturist in 53 plots during the year, and several others were inspected. The records have been sent to Dehra Dun for compilation.

COORG.

I.—Experimental Silviculture.

(v) *Artificial Regeneration.*

North Coorg.

Somwarpet Range.

Dibbling of sandal under heavy shade having proved a failure, the areas were clear felled leaving about 10 trees per acre. A stocking of 30 per cent. was achieved in this way. Even this method would appear to have disadvantage such as—

(1) Root competition between the sandal.

(2) Lack of aeration.

(3) Suppression by faster growing natural regeneration of other species.

(4) Drip.

Sandal is found coming up well for about 4 or 5 years after which the plants begin to die out. Sandal after 4 or 5 years requires plenty of side shade and overhead light.

Introducing hosts with sandal at the same time does not seem to be a good thing as such hosts are frequently killed off by sandal in one or two years. Actually it would be better to introduce such hosts some years before the sandal.

The method of regenerating sandal with *ragi* as a field crop was continued in Fraserpat range during the year.

The following areas were done during the year :—

Locality.	Area in acres.	Cost per acre.	No. of plants.	Height of highest plant.
		Rs.		
Attur	11	46	4,271	4′—5″
Meenkolli	8½	23	2,515	3′—11″

In Attur, *ragi* was sown and collected departmentally. The crop was very poor which was due to heavy rain.

In Meenkolli, *ragi* was sown and collected by the coolies.

Cassia siamea was sown in both the areas as a host plant and is doing very well.

In the 1932 area, no casualties were replaced as the existing seedlings were sufficient. In 1932 Attur area, the *Erythrina* has died back, but in Meenkolli though it has not died back is not doing well. Both the areas have sufficient *Cassia siamea* except in Attur where there are no hosts in 2 small patches.

The following is the present stock :—

Locality.	Area in acres.	Number of seedlings on 1-4-34.	Height of tallest plant.
Attur	16	5,633	10′—4″
Meenkolli	7	1,895	10′—8″

It has been decided to establish a small research station in Coorg which will work in conjunction with the Madras Research Branch. The essential matters are (*a*) Control of spike disease, (*b*) Study of Silviculture of sandal and (*c*) Study of Regeneration of Evergreen Forests. During the year Messrs. Champion, Laurie, and Rammel, (Kenya Forest Service), paid a visit to Coorg.

South Coorg.

Sandal regeneration with a field crop was continued during the year on the same lines as last year. Three areas were taken up. They were—

(1) a 10-acre plot in Kanthur,

(2) a 12-acre plot in Balecove, and

(3) a 10-acre plot in Ganagur.

The first two are in Nagerhole range and the third in Tithimatti range.

The first was an absolute failure. Germination was good but the young seedlings were attacked by rats during the year and only a few of them are now alive. The area is being replanted with teak. The percentage of survivals in the Balecove and Ganagur areas was about 45 and 60 respectively. Seeds of *dhal* (*Cajanus*) and *Cassia siamea* were dibbled to serve as host plants as in the previous year. Unlike last year however except in the case of the Balecove area, the areas were not clear felled. About ten of the original trees were left standing per acre to serve as advance hosts. The sandal plants under these trees were noticed to have suffered from drip.

2. The sandal stumps planted out in the 1932 area and referred to in last year's report have come up very nicely. The percentage of survivals is now 65. The *Cassia siamea* in this area has grown much too dense and is interfering with the young plants. It is being thinned out.

3. In the 1918 Bambookadu plantation the tree pollarded by Mr. Srinivasaya in June 1932 with the object of ascertaining whether pollarding induces spike and referred to in last year's report, since developed spike. It has been uprooted. As a general prescription, the following treatment is now being applied whenever a case of spike is observed :—

All sandal trees within a furlong radius of the affected tree are immediately pollarded and watched as they may be marking the disease. Those showing signs of spike are treated with " Atlas " solution and when dead are removed, the sapwood obtained from them being burnt. So far 20 trees have developed spike in the area during the year. Also known host plants which render sandal susceptible to spike will in future be removed from a newly spiked area.

The removal of the 409 sandal trees from this area because it was thought that their poor condition was due to want of sufficient hosts, has so far had no appreciable effect on the condition of the trees that have been retained. They continue to look as poorly as before.

The Chief Forest Officer after inspecting all the sandal plantations in Coorg is of the opinion that no further plantations should be opened. The ones opened in 1880 show poor stocking and what trees are left are poorly developed. Further research on trying to establish sandal in existing plantations is necessary before opening new ones. Other methods of establishing sandal in Reserves which have been found satisfactory in Madras are being tried which should give better results at less cost.

Burning and cutting back in the second year of formation in teak plantations.—The operation of burning and cutting back young plants in teak plantations during the second year of formation, has had no appreciable effect on the growth in the 1932 Devamachi plantation. As reported last year, in March 1933, 65 of the 70 acres in this plantation were burnt and the young plants in them cut back, five acres being left unburnt as a control area. No appreciable difference in growth could be noticed between the plants in the burnt and unburnt areas.

In the Nagerhole 1932 plantation which was subjected to a similar treatment and where 50 acres were burnt and cut back and the remaining 50 acres were left unburnt, a certain amount of difference was noticed between the plants in the burnt and unburnt portions. The weed growth was markedly less in the burnt portions. The general appearance of the plants in these portions was also much healthier and they certainly looked bigger than in the unburnt portions.

The operation has been repeated this year in the 1933 plantations at Devamachi, Kolangere and Nagerhole where 25, 20 and 22 acres have been left unburnt and 25, 50 and 50 acres respectively have been burnt. It is too early to offer any remarks on the result of the operation.

Burning and cutting back in the second and third year of formation in teak plantations.—To study the effect of this treatment, an acre in the 1932 teak plantation burnt and cut back last year, has been burnt and cut back this year. It is too early to offer any remarks.

To study the effect of root competition.—To study the effect of root competition on young plants, three trenches 25 yards $\times 2\frac{1}{2}' \times 2'$ have been excavated in January last at intervals of 25 yards in a straight line on the edge of the 1933 plantation at Nagerhole. Measurements of plants along these trenches and the intervening spaces will be recorded at frequent intervals.

MADRAS.

I.—Experimental Silviculture.

(i) *General.*

Introductory.—In this brief report it is not possible to give full experimental data to support all the statements made or opinions given, neither does space permit mentioning all the items of work undertaken. For fuller information the Annual Report on Silvicultural Research in the Madras Presidency for the year 1933-34 published separately may be consulted.

A large proportion of the work done has been small scale Stage I. A. experiments in experimental gardens of which there are now eight.

The most important results during the year are probably the confirmation of the enormous advantages of premonsoon planting of teak stumps and the proof that in our more important teak tracts soil aeration by forking gives no advantage over weed removal without forking, and hence the expensive operation of forking can be replaced by cheaper methods of weeding.

(ii) *Natural Regeneration.*

Experiments on different methods of weeding and opening up the canopy over natural regeneration in wet evergreen forests gave no definite results.

Clearing under seed trees of *Hopea parviflora* was found to induce less natural regeneration than in the uncleared control areas.

Burning leaf litter under mother trees of *Artocarpus hirsuta* appears to increase the incidence of seedling regeneration.

Experiments to test the effect of high and low coppicing with and without trimming the stools in dry fuel forests gave no definite results. More carefully designed experiments on a larger scale are being initiated.

Attempts to obtain regeneration from root suckers by trenching round trees in dry fuel forest areas gave negative results.

(iii) *Seeds.*

Seed pre-treatment.—Routine pre-treatment tests with cold, hot and boiling water were done with 22 species. Boiling water treatment improved the germinative capacity of *Acacia auriculiformis*, *Acacia cyanophylla*, *Acacia leucophloea* and *Cassia siamea*, but was harmful for nearly all the other species tried. Soaking in cold water for 24 hours definitely improved the germinative capacity of *Chloroxylon swietenia* and *Gluta travancorica*, and appeared to be beneficial in the case of *Pterocarpus santalinus* and *Terminalia crenulata*. It neither improves nor accelerates the germination of teak seed (40 tests), but does no harm.

Germination of *Cassia fistula* and *marginata* seed was greatly improved by soaking in concentrated sulphuric acid for 15 minutes. *Terminalia chebula* seed germinated better after soaking in lime-water for 24 hours.

Seed storage.—Tests were done with 28 species to determine the longevity of seeds stored in different ways. Results are given in the annual report.

The removal of the pulp from seed of *Santalum album* before sowing gives a very marked increase in the germinative capacity.

Sorting seed into sizes.—Experiments confirmed the result that the practice of sorting out and rejecting the small seed in the case of teak is not justified, the differences in germinative capacity and resulting growth from small and large seed being too small to matter.

Tests with seed from small immature, normal mature and large overmature seed bearers with several species gave inconclusive results.

Ripe seed collected at different periods during the fruiting season all gave uniformly good germination in the case of teak and *Terminalia crenulata.*

Seed origin.—Short-term experiments in the All-India Teak seed origin investigation again confirmed the superiority of local seed (Nilambur and Mount Stuart) as regards ease of getting germination and

in growth with the exception of South Bombay plants raised from stumps at Nilambur which, though they start more slowly, have by the first hot weather outstripped the Nilambur origin plants. Attempts to establish long-term plots were frustrated owing to failure of seed of certain origins to germinate in the nursery.

(iv) *Nursery Work.*

Shading.—In hot dry fuel areas shading nursery beds gave higher germinative capacity with almost all species tested, but as regards subsequent development individual species exhibited different requirements.

Nursery methods for raising teak stumps.—A comparison of (A) dense sowing with seed almost touching, (B) Transplanting small seedlings into beds 4″ × 4″ espacement, (C) Notching germinating seed from dumps 4″ × 4″ espacement and (D) Sowing soaked seed in lines 3″ × 1½″ espacement, showed that method (A) gave by far the greatest number of useable stumps per bed, though it is the most wasteful of seed. The beds, however, after removing the required stumps in the first year, will be again fully stocked with useable stumps at the end of the second year. The other three methods in no cases gave fully stocked beds, though the stumps produced were larger. Where the cost of seed collection is low and the cost of nursery space high method (A) is evidently preferable.

(v) *Artificial Regeneration.*

(*a*) *Mixed deciduous forest.*

The stocking of felling gaps in mixed deciduous forest with teak is now extensively carried out and presents no difficulties in the initial stages. There is some cause for apprehension in certain areas however where climbers and lantana are particularly aggressive that the plants may be swamped by invasive growth in later years after tending has ceased.

An experiment comparing the effect of a heavy burn, a light burn and no burn in such gap regeneration showed no difference in results between the two intensities of burn, but the gaps with no burn were definitely inferior.

Comparison of direct sowing, entire transplanting and stumping.—The decided superiority as regards both survivals and resulting height growth of stump-planting teak in preference to either direct sowing or entire transplanting was confirmed. *Dalbergia latifolia, Pterocarpus marsupium* and less definitely *Terminalia crenulata* gave the same results. *Xylia xylocarpa* gave the best results from direct sowing.

Optimum season for stump planting.—Repetitions of the premonsoon stump planting experiments confirmed the previous results. The conclusions that may be drawn from these experiments, which have now been repeated six times, are :—

(*a*) Except in unusually dry and hot seasons, stump planting as early as the first week in April gives sufficiently good stocking (over 90 per cent. on the average) and an immense gain in height growth as compared with normal monsoon planting at the end of May or early in June.

(*b*) Success is not dependent upon what is generally considered good planting weather.

(*c*) The stumps will stand fairly long periods of drought after they have been put in and even after they have sprouted.

(*d*) The immense advantage given by the start the teak gets over weeds or field crops more than outweighs any risk of bad stocking due to an exceptionally hot or dry season, or to other causes, and this risk can be cheaply insured against by providing a reserve of plants for stumping in the last fortnight of May should the necessity arise.

Similar experiments were done with stump planting of *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Xylia xylocarpa* and indicated that early planting is also beneficial in these cases though the differences are not so great as in the case of teak.

Stump planting.—Effect of diameter of stumps.—Teak stumps of 0·4″ to 0·7″ diameter at the collum (=0·6″ to 0·85″ diameter at the thickest part approximately) gave the best results. Larger stumps gave inconsistent results. Smaller stumps usually gave poorer survivals and height growth. In the case of *Dalbergia latifolia* stumps 0·2″ to 0·4″ and possibly 0·5″ collum diameter appear to be best, and in *Terminalia crenulata* medium sized stumps (0·5″ to 0·7″ collum diameter) gave the best results both larger and smaller sizes usually giving poorer growth, though the effect on survivals was negligible. In *Pterocarpus marsupium* stumps up to 0·4″ collum diameter were tested, the largest sizes giving the best results.

Stump planting.—Effect of length of root—Teak.—Repetitions of last year's experiments indicated no definite relationship between length of root (between 4″ and 10″) and either percentage of survivals or resulting height growth.

Stump planting.—Comparison of pits and crowbar holes.—Experiments confirmed the slight advantage of 1 foot cube pits over crowbar holes, but the difference in growth is normally not likely to be worth the extra expense of digging pits.

Storage of stumps.—Stumps stored for 27 days before planting gave 78 per cent. survivals, the percentages falling off to 68 per cent. after 34 days, 24 per cent. after 41 days and 4 per cent. after 49 days' storage.

Casualty replacements with stumps in the second year of a teak plantation were watched. Only 19 per cent. survived after two years in one experiment and those survivors were not taking their place in the main crop. In another experiment 77 per cent. were surviving after one year. They are being watched.

A *taungya* crop of *ragi* (millet) had a definite retarding effect on the growth of teak in a plantation. With stumps planted on 6th May 1933 the heights by next February were $0{\cdot}60 \pm 0{\cdot}035$ feet in the *ragi* strips and $0{\cdot}86 \pm 0{\cdot}051$ feet in the control strips, *i.e.*, a difference of 27 per cent. in height growth. An experiment with early and late stump planting in the same *ragi taungya* showed that by planting as early as the 21st April, an increase of height of over 100 per cent. in the teak as compared with late planting (1st June) was obtained. Early stump planting should therefore go a long way towards counteracting the retarding effects of *taungya* crops.

(*b*) *Evergreen Rain forests.*

All artificial regeneration work in evergreen rain forests comes under the category of underplanting and is, therefore, dealt with in part (ix) of this Chapter.

(*c*) *Dry Fuel forests.*

Artificial regeneration of dry fuel forests by the "rab" method has been undertaken on an increasing scale in almost all divisions in which this type of forest is found. *Cassia siamea* and *Dolichandrone crispa* are probably the two most popular species used, with *Albizzia amara, Acacia sundra, Melia indica, Acacia ferruginea* and *Prosopis spicigera* as the next most important species. *Anacardium occidentale* has also been tried in some dry localities but, though it germinated freely, it has not grown with the rapidity one expects of it. *Cassia siamea,* hitherto regarded as a hardy species, has in one or two localities died out in the exceptionally severe hot weather this year even when over six feet high and considered to be well established.

A large amount of experimental work has been done at Chittoor, but the yield of results has been meagre owing to the rigorous nature of the conditions there. The following indications were however obtained :—

(*a*) Sowing in the open generally gives better results than sowing under the shade of existing fuel forests.

(*b*) Sowing in burnt patches gives better results than sowing in patches without a burn.

(*c*) Seedlings that survive the first hot weather are by no means necessarily established. They may succumb in the second or subsequent hot weathers. In the case of *Acacia sundra*, *Prosopis spicigera* and *Albizzia amara*, however, no further casualties occurred in the second hot weather.

The light-demanding nature of *Cassia siamea* has been clearly established. Whenever this species was grown under shade of any kind survivals and growth were much reduced.

Cassia siamea gave better results from stump planting than direct sowing both as regards height-growth and survivals. The opposite was the case with *Anacardium occidentale* which gives very poor survivals from stumps.

Experiments to determine the best season for entire transplanting in dry fuel areas indicated that :—

(*a*) July planting almost invariably gave better survivals and height growth than October planting by the following June.

(*b*) *Acacia sundra* did not give good results with entire transplanting and *Cassia siamea* gave practically no survivals and appears to be quite unsuited for this method of regeneration.

Stump planting of fuel species.—Indications given by various experiments are :—

(*a*) July appears to be a better month for stump planting most species than August, September, or October.

(*b*) *Acacia auriculiformis* and *Anacardium occidentale* are unsuited for stump planting giving very few survivals.

(*c*) *Cassia siamea* and *Prosopis spicigera* gave good results from stumps.

(*d*) No marked difference between the results from stumps with short roots and long roots (9 inches and 15 inches) was found in the case of *Cassia siamea* and *Prosopis spicigera*.

Santalum album.—Attempts to raise sandal among bushes by direct sowing in saucer shaped depressions covered with straw, (*dhall* seed being sown at the same time), were unsuccessful at Chittoor. Stump planting of sandal in North Salem division has given 98 per cent. survivals after three years with an average height of 4 feet 5 inches, and a maximum height of 9 feet. Planting pieces of roots cut from living trees gave indications of success.

(vii) *Tending, Thinning and Cleaning.*

Confirmation was obtained of the harmful effects of leaving seedlings and transplants of *Dalbergia latifolia* unweeded.

The marked beneficial effects of A-forking in four foot wide strips as compared with B, scraping in 4 foot wides strips, C forking in 4 foot diameter circles and D weed-cutting in strips (done in 1931) were found to have diminished considerably by the third year, and will probably be scarcely discernable after 5 years.

A further confirmation of the result that forking in 4 feet wide strips is better than forking in circles of 4 feet diameter was obtained showing that the effect of weeds as far away as 4 feet from the young teak plants is sufficiently great to cause a significant difference in height growth.

In a plot kept clean weeded during the first year the height of the teak was 130 per cent. greater than in the adjoining divisional *taungya* area with a *ragi* crop. (The cost of this clean weeding was however Rs. 31-9-0 per acre.)

Definite confirmation was obtained in two localities (6 experiments altogether) that monthly forking throughout the year produces no increase in growth as compared with clean weeding without loosening the soil. It is evident therefore that soil aeration in itself does not confer any appreciable benefit over and above the effect of removing weeds. The expensive operation of forking in strips (Rs. 8 to Rs. 11 per acre) is therefore unnecessary and can be replaced by scrapings which cost only Rs. 4-8-0 to Rs. 5-8-0 per acre. The experiments were only done in areas with a naturally light friable soil and a rainfall of 60 to 120 inches. The results may not be applicable to dry localities, or places with a stiff heavy soil.

Repetitions of experiments to test the effect of cutting back and burning a teak plantation in the year after planting were done too late, and showed that whereas the burnt and cut-back plants grew significantly more than the plants cut back without burning, neither of them overtook the uncut control. It is expected that this reversal of the previous year's result where the burnt and cut-back strips grew significantly larger than the uncut unburnt control is probably due to the experiment having been done after the teak had started growing.

Experiments in the use of *Tephrosia candida* as a cover crop indicate that if introduced in the first year it is an unmitigated nuisance as a weed, and if introduced in the second year (in the Wynaad) it does very little practical good as its effect as a weed suppressor does not come into action until the teak is well out of danger of weeds. It is also very badly browsed by bison.

(ix) *Underplanting.*

Evergreen rain forests.—Underplanting experiments with evergreen species under the full canopy of evergreen rain forest have shown such exceedingly small growth (sometimes un-measurable after two years) that results are slow to obtain.

With the exception of *Artocarpus hirsuta* experiments in the stumping of evergreen species were all almost complete failures.

In areas with very heavy south-west monsoon rainfall (over 140 inches during July, August and September alone and a total rainfall of over 200 inches) the best season for entire transplanting was found to be August to October, but in areas with only 60-80 inches of rainfall planting in June to July gave the best results.

Artocarpus hirsuta gave slightly better results from entire transplants than from stumps.

No definite superiority in survivals was shown by large transplants of *Hopea parviflora, Mesua ferrea, Calophyllum elatum, Artocarpus hirsuta, Dysoxylum malabaricum* and *Gluta travancorica* as compared with small transplants, but the growth of the large transplants, where measurable, was greater than that of the small transplants. Transplanting in pits showed a slight superiority over transplanting into crowbar holes. Natural forest seedlings of *Hopea parviflora* gave slightly better results than nursery seedlings of the same size. The reverse was the case with *Mesua ferrea.* All these results are however unreliable owing to the very small growth obtained under evergreen shade.

(xi) *Miscellaneous.*

A small trenching experiment in dry fuel forest with direct sowings of *Prosopis spicigera* inside and outside the trench gave a significant increase in growth inside the trench due to removal of root competition by severing the roots of surrounding trees.

Experimental cultivation of *kollukattai* grass (*Pennisetum chencroides*) in Central Salem and Madura Districts to improve grazing in reserves gave promising results.

II.—Working Plans and Statistics.

(i) *Working Plans.*

Five Working Plans were under compilation at the beginning of the year, of which two were completed. Two new plans were started and preliminary work for a third commenced. Three new plans were sanctioned during the year. The cost of preparation inclusive of establish-

ment varied from Re. 0-1-7 to Re. 0-3-3 per acre, depending upon the amount and intensity of the stock-mapping and enumerations necessary.

(ii) *Yield, Volume and Form Factor Tables.*

Eighty-eight permanent sample plots were maintained. Data for local commercial volume tables were collected and the tables were compiled by the silvicultural branch of the Forest Research Institute, Dehra Dun.

Seven linear tree-increment plots have been laid out for determining the increment of the more important timber species growing in mixed forests.

(iv) *Miscellaneous.*

Ring countings on teak stumps in natural forest at Mount Stuart were continued for determining (by correlation with felling data) the increment of teak in natural mixed forest.

III.—Miscellaneous.

1. *Tours, records, etc.*

The Central Silviculturist toured in the Madras Presidency between January and the middle of March 1934. The Provincial Silviculturist accompanied him throughout the tour, including visits to the State Forests of Travancore, Cochin and Mysore, and to Coorg.

Records.—The specific and general ledger files now number 391 and 116 respectively, 21 new experimental plots were opened during the year, and 249 experimental garden experiments were started or maintained. 331 photographs were added to the collections of which 159 were taken by the Central Silviculturist.

Staff.—An Extra Assistant Conservator of Forests was attached to the Division as Assistant Silviculturist from December 1933. The subordinate staff now consists of 3 Rangers, 7 Foresters, and 1 Forest Guard.

Sandal spike disease research.—The department collaborated with the Indian Institute of Science at Bangalore, and with the Forest Entomologist in connection with their investigations into spike disease. On the cessation of the Government grant to the Institute with effect from the end of March 1934 the control of all spike disease research done by the Forest Department has been handed over to the Provincial Silviculturist.

2. *Weeds.*

Lantana.—Experiments to see whether Lantana can be suppressed by undersowing with *Bambusa arundinacea* have shown a promising start. An attempt at controlling Lantana entomologically by the introduction of the insect *Orthesia insignis* met with partial success and is being pursued.

Climbers.—Experiments in the eradication of *Zizyphus oenoplea* and *Acacia intsia* by poisoning them with solutions of sodium arsenite of different strengths have indicated that almost complete eradication of the *Zizyphus* and the *Acacia* can probably be attained by these means at a reasonable expenditure on chemicals. It is, however, too early to judge final results yet.

NORTH-WEST FRONTIER PROVINCE.

I.—Experimental Silviculture.

(i) *General.*

Owing to the great delay that has occurred in obtaining adequate blue pine regeneration in forests being worked under the uniform system, silvicultural research has, in recent years, been devoted largely to finding out the best methods of restocking the compartments felled over.

(ii) *Natural Regeneration.*

The sample plots laid down in Pattan reserved forest to ascertain the most suitable intensity for a seeding felling in blue pine forests have given no definite results, but a careful examination of all compartments in which a seeding felling has been made leads to the conclusion that one crown's distance between the crowns of the mother trees is a standard that will satisfy all requirements of a seeding felling.

The intensity of felling appears, however, to play less part in obtaining natural regeneration than the condition of the soil, the best indicator of which is the ground flora. Most of the delay that has occurred in obtaining blue pine regeneration is undoubtedly due to the soil having a deep A horizon, indicated by such weeds as balsam and dock. As the depth of the A horizon has been reduced, these weeds have given place to strawberry and other indicators of a good soil condition, and in such places regeneration is now coming on well.

(*iii*) *Seeds.*

Local deodar seed from the Kagan valley has again given very poor results. Kulu seed was better, but by far the best results were obtained from the Langet division of Kashmir.

1933 was generally a good seed year for blue pine. In Kagan division the number of cones was counted on twenty-one trees which gave an average of 201 cones per tree.

(iv) *Nursery Work.*

Wire mesh netting buried one foot in the ground with the end turned away from the nursery has effectively checked damage from voles. It is, however, necessary to kill the voles which are left inside the netting by thoroughly treating the whole nursery with a cynogas pump.

Five more nurseries to raise deodar and walnut were started during the year.

(v) *Artificial Regeneration.*

The sowing and planting of walnut in the Galis division in wire mesh netting cylinders continues to give satisfactory results. In fact, this is the only method possible where there is danger of damage from voles. It is, however, expensive, and as an attempt to reduce the cost thick paper cylinders soaked in kerosine were tried last year. In almost all cases the paper has now rotted away and it appears that rather less than a year's immunity can be obtained by this method. By far the most successful method of propagating walnut is by means of root and shoot cuttings made from one year old nursery plants, the percentage of failure by this method being negligible.

Patch sowings of deodar under a blue pine overwood germinated well, but suffered heavily from the extreme drought in the following autumn. Considerable damage to the seedlings when they first germinated was also done by cut-worms and birds.

Willow and poplar cuttings, planted over large landslips in the Galis division, gave about 50 per cent. success.

Experimental sowings of mesquite (*Prosopis juliflora*) were made in the Jowlian forest of the Khanpur range, both Kharian (Punjab) and local seed being used. Sowings were made soon after the break of the monsoon in drills on the berm of trenches. Previous to sowing part of the seed was soaked in cold water for 48 hours; another portion was placed into boiling water and allowed to soak for 24 hours; while a third portion was placed in boiling water and allowed to soak for 48 hours. All the seed germinated, but the best results were obtained from the seed placed in boiling water and soaked for 48 hours. The germination in this case was quick and the plants vigorous. Plants from the Kharian seed all subsequently died; those from local seed still survive. Whether they can establish themselves remains to be seen.

(xi) *Miscellaneous, including Fire and Grazing.*

Experimental burning of *chir* regeneration areas in which the regeneration was well established was continued. It has now been established that such areas can safely be burnt departmentally under control during the winter without any appreciable harm coming to the young growth provided the right technique is carried out.

Experimental grazing of cattle was allowed during the rains in *chir* regeneration areas in the Galis division where there is a good growth of seedlings and grass is luxuriant. It was found that the cattle did not eat the *chir* seedlings, and the slight damage by trampling was more than counterbalanced by the advantage of keeping down grass.

In blue pine regeneration areas complete closure has led to very luxuriant weed growth, in which natural seedlings have little or no chance of survival. The only practical method of keeping down this heavy weed growth is to allow grazing during the rains. In the Galis division the compartment containing the best natural regeneration is one which it has been impossible to close owing to the existence of grazing rights.

II.—Working Plans and Statistics.

(ii) *Yield Tables, etc.*

Statistical data were collected for standard and commercial volumes from 100 deodar and 60 blue pine trees in the Lower Kagan forests. These were forwarded to the Silvicultural Research division, Punjab.

PUNJAB.

I.—Experimental Silviculture.

(i) *General.*

The triennial programme of work for the Silvicultural Research division was revised.

A field party from Dehra Dun visited bamboo plots in the Hoshiarpur division and carried out fellings in a set of experimental plots.

Mr. M. L. Mehta, Land Reclamation Officer, took soil profiles in Bajraundi and Monalgahr forests, Kulu division.

(ii) *Natural Regeneration.*

Silver fir and spruce—Silvicultural Research division.—Very little progress was recorded in experimental plots at Pulga, Bajraundi, Monal-

gahr and Kaisdhar, which were laid out to study natural regeneration. Assessments of regeneration in the indicator plots shewed greater success in the establishment of seedlings on burnt ground and on mineral soil artificially exposed by the removal of thick humus covering the ground.

In the fir regeneration areas of the Kulu division, regeneration was unsatisfactory in the higher parts but was coming in well in the lower parts. According to the Divisional Forest Officer, this difference was due to the heavy growth of *Strobilanthes* and other herbs combined with the concentration of grazing during certain season in ' thatches ' just near the upper boundaries which were not nearly so well protected as the lower boundaries.

Pinus excelsa.—In experimental plot 22 which was laid out in typical high level blue pine crop at Pulga, no new regeneration was recorded.

(*iii*) *Seeds.*

Seed weighments.—In the research nursery at Manali, the total number of weighments was 434 for 17 species, covering 12 conifers (including 6 exotics) and 5 important local broad-leaved species. The bulk of the work was done for *Cedrus deodara, Pinus excelsa, Abies webbiana* and *Picea morinda* for which weighments were taken separately for seed obtained from trees of different sizes, dominance classes and local altitudinal races occurring in the Kulu division.

At Lahore, 60 weighments were recorded for 10 new species including four different forms of *Prosopis juliflora.*

Seed year.—1933-34 was a moderate seed year for all conifers. Seed was exchanged with Forest Research Institute, and all inter-divisional indents of seed were arranged.

Seed ripening.—Populus euphratica.—Germination tests with weekly collection of seed from trees in the Jhok reserve shewed that only seed contained in fully or partially open capsules from the middle of August to the end of September was ripe, though fruiting commenced in the beginning of June and continued to the middle of October. Capsules were picked off the trees into cloth bags.

Tamarix articulata.—At Chichawatni ripe seed was available from July—October. At Lahore, the seed crop was poor and much damage was done by the insect, *Niaococcus serpentinus.*

Germination tests.—In research nurseries at Manali and Chichawatni germination tests with or without pre-treatment were made either as a routine measure preliminary to experimentation or as special and independent investigations.

Untreated seed.—Untreated seed of *Cupressus torulosa, Larix griffithii, Alnus nitida, Cedrela serrata,* and *Ulmus wallichiana* gave poor results.

With spruce, silver fir and deodar no significant difference was observed in the germinative capacity of seed obtained from different diameter classes, average germination percentage for these species being 6, 34 and 62 respectively.

No germination was obtained with untreated seed of *Dendrocalamus hamiltonii, Bambusa nutans* and *Wendlandia exserta.* With untreated seed of *Dendrocalamus strictus, Dodonaea viscosa, Morus alba* and *Tecomella undulata,* germination percentage was 43, 44, 16 and 29 respectively.

Aids to germination.—Aid to germination included pre-treatment of seed by immersion for different periods in cold and hot water or in standard solution of acid and other chemicals. In the elaborate tests, different soil media were also used, seed being sown both in the open and under shade. In some cases outer hard shell of seed was mechanically ruptured or clipped.

Acacia modesta.—Treatment of seed with cold water made an appreciable improvement in the germination capacity ; soaking in hot water was harmful.

Dalbergia sissoo.—Germination percentage was higher for untreated seed ; soaking in cold water did not improve the germination capacity.

Melia indica.—With seed soaked in cold water, average germination percentage was 23 in the open as well as in the shade ; different soil media practically made no difference in the germination percentage obtained.

Olea cuspidata.—Germination percentage with seed sown in typical forest soil brought from under olive trees was 26 per cent. Immersion in 5—10 per cent. solution of sulphuric acid, and apex clipping improved the germinative capacity of the seed.

Prosopis juliflora.—With pods soaked in cold water, the germination percentage was 5 for Mexican and Peruvian forms, and 12 and 23 for Arid and Australian forms respectively.

Zizyphus jujuba.—Average germination percentage was 14 for seed treated with hot as well as cold water.

Larix europaea.—Treatment with hot and cold water made no difference in the germinative capacity.

Fraxinus micrantha.—Treatment with cold water did not hasten germination at Monali.

Seed storage.—In the research nursery at Manali, cloth bags and sealed tins were used as standard containers for seed storage. For *Pinus excelsa, Picea morinda, Abies webbiana, Cupressus torulosa* and

Larix europaea, no difference was observed in the germinative capacity of seed, with the use of these containers, germination tests being made after storage for various periods from 6 months to 2 years. Unfortunately initial germination percentage records were not maintained, and so germinative capacity after storage could not be compared.

At Lahore, seed was stored in tins. Germination results obtained with seed before and after storage are tabulated below :—

Species.	Initial germination per cent.	Germination per cent. after storage.	Period of storage (months).
Acacia catechu	63	58	15
Acacia modesta	75	30	18
Bombax malabaricum . . .	13	5	12
Butea frondosa	91	12	10
Prosopis juliflora	53	15	11
Olea cuspidata	47	26	18

Investigations on seedlings.—A commencement was made with the study of seedlings of important species, with special reference to the development of underground parts. Drawings of root systems were prepared for *Cedrela toona, Dendrocalamus strictus, Prosopis juliflora, Prosopis spicigera, Shorea robusta, Tamarix articulata* and *Thevetia neriifolia.*

Investigation was taken in hand to study the causes of damping off of seedlings in the nursery, including injuries caused by soil insects.

Investigations on trees and crops—Seasonal height growth.—At Manali, seasonal height growth was recorded for *Cedrus deodara, Pinus excelsa, Picea morinda, Abies webbiana, Populus ciliata, Acer pictum* and *Cedrela serrata.* At Chichawatni similar measurements were recorded for *Acacia catechu, Bombax malabaricum, Butea frondosa, Dendrocalamus strictus, Morus alba* and *Tamarix articulata* raised from seed as well as stumps. *Acacia catechu, Bombax malabricum, Butea frondosa, Capparis aphylla* and *Dendrocalamus, Prosopis spicigera* and *Prosopis juliflora* were all killed back by severe frost during winter (January—February). Only the tips of branches were killed in the case of *Dalbergia sissoo, Morus alba* and *Zizyphus jujuba.*

Change in diameter distribution with growth of crop diameter.—Fortnightly d. b. h. measurements were recorded for deodar and *kail* in Kulu and for *Dalbergia sissoo* in Chichawatni. The data await analysis.

(iv) Nursery Work.

Research nurseries and experimental gardens were maintained at two Research Stations—Manali in the hills and Chichawatni in the irrigated plantation in the plains.

In these nurseries a large stock was raised of species required for experimental work as well as for distribution to territorial divisions. In addition a large number of experiments were carried out.

Cultivation of exotics.—The following exotics were tried :—

Research nursery at Manali.—Pinus patula, P. taeda, P. pinaster, Pseudotsuga taxifolia, Chamæcyparis obtusa, Larix europœa, Cryptomeria japonica, Taxodium distichun, Fagus sylvatica, Quercus rubra, Populus monilifera, P. generosa (cuttings), *Tilia vulgaris* and *Castanea sativa* (branch cuttings).

Kulu division.—Larix europaea, Acacia saligna, Rhus lancea, Eucalyptus hemiphloia, E. rostrata, E. terminalis and *E. trachyphloia.*

Multan division.—Maclura aurantiaca, Celtis eriocarpa, Schinus tere binthifolius, Acacia farnesiana, Terminalia sericea, Eucalyptus melanophloia and *E. naudiniana.*

Kangra division.—Swamp Cypress (*Taxodium mucronatum*).

Stock of broad-leaved species.—Stock of the following species was raised :—

(i) *Sowings.—Ulmus wallichiana, Cedrela serrata, Alnus nitida, Populus ciliata, Dendrocalamus strictus, Morus alba, Populus euphratica, Tamarix articulata* and *Tecomella undulata.*

(ii) *Root and shoot cuttings.—Populus cileata, Juglans regia, Aesculus indica, Acacia catechu, A. modesta, Butea frondosa, Capparis aphylla, Dendrocalamus strictus, Melia azedarach, Zizyphus jujuba, Prosopis juliflora* and *Morus alba.*

In the Kangra division, about 100 teak root and shoot cuttings put out in Dhamtal were successful.

(iii) *Branch cuttings.*—Branch cuttings succeeded in the case of *Acer pictum, Fraxinus micrantha, Alnus nitida, Populus ciliata, Ulmus laevigata* and *Morus alba.* Cuttings of *Buxus wallichiana* failed.

Planting of alder stakes was tried in the Kulu division and pegging of pollarded shoots of *Cotoneaster bacillaris* in the Bashahr division.

Experiments.—Effect of density of sowing on survival percentage.—For *Pinus excelsa* and *Picea morinda* significant negative correlation was observed between density of sowing and plant percentage. *Abies webbiana* seed gave very low germination, and so observations were not recorded.

Effect of different types and depths of humus.—Types of humus were fully decomposed, partially decomposed, and undecomposed raw litter, and depths of humus deposits ½″, 1″, etc., to 4″. Germination of spruce and silver fir, though poor on the whole, was significantly better in beds covered with a deposit of decomposed humus up to 1½″ deep. Soil surface matted with raw litter and only partially decomposed humus was found unsuitable as seed bed, and inimical to the development of young seedlings.

Effect of size of seed on germination and survival percentage.—*Aesculus indica* seed was graded by size classes, 1½″ and over and under 1½″ in diameter. Germination and plant percentage was significantly higher for the bigger size class.

Restriction of tap root development.—To induce development of fibrous root system at the expense of tap root, galvanized iron sheets were placed 6″ below the surface of the beds which were then sown with deodar, spruce and silver fir seed. The experiment is not yet concluded.

Slicing tap root.—The tap root of deodar and blue pine seedlings in the beds was sliced off, and the seedlings pricked out. The experiment is still in progress.

Effect of weeding on Picea morinda.—The intensity of weeding had a marked influence on the height growth of seedlings, which was definitely very poor in the unweeded beds as compared with that in the weeded beds. Weeding, however, made no difference in the survival percentage both for *Picea morinda* and *Abies webbiana*.

Effect of weeding on Morus alba cuttings.—Weeding in lines planted with mulberry cuttings did not give significantly better growth than the unweeded lines. This was probably due to the fact that weed growth was rather poor in unweeded lines. The survival percentage was higher in the weeded lines.

Effect of shading, weeding, etc.—With *Morus alba* and *Dendrocalamus strictus* moderate shade of *kana* mats (66 per cent.) combined with weeding was found to give the best results. Leafing commenced earlier in the weeded beds.

Size of root and shoot cuttings for planting.—*Morus alba* and *Tamarix articulata* cuttings having standard lengths of 6″, 9″ and 12″ were graded by ¼ inch diameter classes. These were planted flush with the ground, and leaving shoot 1″, 2″ and 3″ above it. Cutting of all sizes gave uniformly good results, irrespective of the depth of planting. Slightly better results were indicated with 12″ cuttings of *Tamarix*, having ¼″ to ½″ diameter at the collar.

Different methods of planting.—Entire planting of *Capparis aphylla* and *Melia azedarach* succeeded at Chichawatni with irrigation, but failed

in the case of *Acacia catechu, Acacia modesta, Dendrocalamus strictus* and *Tamarix articulata.*

Different seasons of sowing.—At Manali much better germination was obtained with spruce seed sown in winter than in spring.

In the Lower Bashahr division good results were obtained by sowing silver fir during spring and rains, and spruce during winter and spring.

In the Kulu division silver fir seed sown during March 1933 gave good results considering both germination percentage and condition of plants.

Different seasons of planting.—Cuttings of *Tamarix articulata* planted monthly from August to October 1932 indicated the superiority of August planting. The same experiment was tried in 1933, planting being done fortnightly from April to September. May and August planting gave significantly higher sprouting and survival percentages.

(*v*) *Artificial Regeneration.*

Transplants—Abies webbiana and Picea morinda.—Abies webbiana planted in tubes in experimental plot No. 30 did well during the year. Transplants of spruce in experimental plot No. 45 gave 50 per cent. success.

Cedrus deodara.—Deodar transplants in experimental plot No. 51, Rahni, (713 plants), in experimental plot No. 30, Monalgahr, and experimental plot No. 40, Kaisdhar, (550 plants), gave 66 per cent. success. No mortality occurred in the case of 37 seedlings transplanted in tubes. Deodar transplants on fire burnt areas at Nagni gave good success.

Pinus excelsa.—In *kail* transplants in experimental plot 52, Bajraundi, (586 plants), fairly low mortality was recorded, but the general appearance of the plants was far from healthy. In Rahni, only 30 percentage of seedlings survived.

Experimental planting of seedlings with different degrees of root and shoot pruning did not lead to any useful results, practically the same amount of success being obtained in every case.

8 out of 11 seedlings planted in tubes succeeded.

Kail transplants at Nagni failed in the burnt area.

Pinus longifolia.—In the Hoshiarpur division, 485 *chil* seedlings raised in bamboo tubes and planted during the rains gave about 75 per cent. success.

Cupressus torulosa.—Both sowing and planting of *Cupressus torulosa* in the Kulu and Kangra divisions succeeded.

Rhus viminalis—Multan division.—Of 127 seedlings transplanted under 9 years old *shisham* crop, 118 survived with an average height of

5·3′. Among 25 seedlings transplanted in the Rest House compound heavy casualties occurred, due probably to lack of shade.

Larix europæa 1½ year seedlings transplanted in December in Monali Rest House compound gave 100 per cent. success.

Prosopis juliflora.—In the Depot West division, *Prosopis juliflora* was found quite suitable for reafforestation works in dry *rakhs.* Over 20 acres sowings were done with a fair amount of success on small ridges made by heaping earth 6″ away from trenches dug along the contour. The work was done on the *taungya* system, zamindars being allowed to raise ' *bajra* ' crop in between the trenches. Casualties were chiefly due to drought in autumn and frost in winter.

In the plantation at Phillaur, *Prosopis juliflora* sowing and planting done in early rains along trenches in understocked area proved successful. Bunds were made where necessary to collect and conserve rain water for the plants.

Tamarix articulata.—In the Montgomery division, various methods of sowing *Tamarix articulata* were tried. Sowing was done (*a*) in shallow beds, 4′×4′×4″, dug in centres between trenches, (*b*) in shallow pits, 1½′×1½′×5″ filled with *kallar* soil, (*c*) on percolation beds 1½′×1′×6″ surrounded by irrigation channel, using 6″ of black *kallar*, (*d*) on berms of trenches and (*e*) on berms of circular pits 2½′—3′ diameter and 1′ deep connected with irrigation trenches by means of narrow 2′ long ditches. The last method gave the best germination result on black *kallar* soil, and was found most economical in the use of water.

For transplanting, seedlings were raised in bottomless pots placed upside down in shallow beds and watered by percolation, the inverted position of pots facilitating the removal of seedlings by gentle tapping. Seedlings 2″—3″ high were planted on mounds surrounded by narrow irrigation ditches to prevent water logging. This method gave much better results at Arafwala and Dipalpur than transplanting seedlings from the nursery with naked roots and balls of earth. As with sowing, the best results were obtained on black *kallar* soils.

(*xi*) *Miscellaneous Experiments.*

Depth of irrigation experiments.—Measurements were taken in the research experimental plots 12 to 13 at Chichawatni laid out to determine the optimum depth of irrigation required for maximum volume production of *Dalbergia sissoo* crop. The range of irrigation was 3′—4′ for experimental plot 12 and 2′—4′ for experimental plot 13.

In the Multan divison the depth of irrigation experiments for *farash* and *shisham* were continued.

In the Miranpur range the growth of *farash* was found unsatisfactory with the reduced delta of water given in 6″×6″ trenches.

A series of new depth of irrigation plots were laid out in the Lahore division.

Best age of cover crop for underplanting mulberry.—In the Multan division experiments carried out shewed that mulberry could be most successfully introduced in 1-3-year old *shisham* crops and 1—2-year *farash* crops. The opening of the canopy and intensity of light admitted were more important factors than mere age.

In the Lahore division a new series of plots was laid out to determine the best age of cover crop.

In the Montgomery division it was experimentally shown that attempts to stock new areas by direct planting without the cover crop of *shisham* were futile even with 5′ delta.

Bamboo experiments.—Hoshiarpur division.—In the experimental plots laid out by the Forest Research Institute, Dehra Dun, necessary prescribed fellings were carried out by a field party from Dehra Dun.

Espacement experiments.—In the espacement plots at Chichawatni, comparable thinnings were carried out in the *shisham* crops in sub-plots with spacement 5′×10′, 6′×10′, 7′×10′. No thinnings were called for in 8′×10′ and 10′×10′ sub-plots. The intensity of thinning in each sub-plot was tested by plotting on a provisional N/D curve. Necessary sample plots measurements were also recorded.

Succession of vegetation.—In the Lower Bashahr division, the record of ecological succession in the experimental plots in burnt areas was maintained. The botanical collection was identified by the Forest Botanist, Dehra Dun.

Soil studies—Research Division.—A series of soil profiles representing areas characterised by the presence or absence of spruce fir regeneration were taken and examined by the Irrigation Research Institute.

The following conclusions were tentatively drawn:—

(*a*) Areas without regeneration were characterised by a deep " A " horizon of high organic content, and conversely, areas where regeneration took place, were characterised by a shallow " A " horizon.

(*b*) Mortality among seedlings during the dry period following the melting of snow was due to the large amount of unavailable water in " A " horizons due to their water holding capacity.

(*c*) The soils belonged to the podsol group, but were immature in development due to the annual period of drought.

(*d*) The degree of podsolisation appeared to be determined by the depth of the peaty layer.

Multan division.—Preliminary tests carried out with Le Motte field apparatus shewed that the average *shisham* soil in Khanewal plantation was circumneutral while the typical *farash* soil was definitely neutral.

Grass experiments.—In the *bhabar grass* experimental plots, Simla division, the prescribed operations were carried out. It was decided, however, to discontinue the grazing experiment, as it was difficult to get the graziers to the plots for the few days for which grazing was prescribed.

In the Rawalpindi East division, observations in the grass plot shewed that continuous grazing reduced the yield of grass, closure for a number of years being necessary to allow the grass to seed and grow in abundance to obtain full yield.

In the Kangra division, *Ischæmum angustifolium* (*bhabar*) and *Andropogon cŏntortus* were sown broadcast during the winter in a badly eroded area in Tiloknath but nothing came up. The area was inspected by Fodder Specialist.

Lac Cultivation.—In the Rawalpindi East division, experimental cultivation of lac was continued in Jhilla Cherah compartment 51 and extended on a small scale to Keral compartment 32 in Kahuta range. The summer crop on *ber* and *dhak* was a fair success but unfortunately the timely removal of lac was neglected. Winter inoculation did not prove successful.

II.—Working Plans and Statistics.

(*ii*) *Yield, Volume and Form Factor Tables.*

A feature of the year's work was the increasing interest taken in the application of the statistical method and the realization of its usefulness.

Full measurements were taken in 16 and *interim* measurements in 5 sample plots. No new sample plot was laid out.

Standard and commercial volume data were collected in Kangra, Upper Bashahr, Lower Bashahr, Seraj and Rawalpindi East divisions.

(*iii*) *Miscellaneous.*

Measurements were taken for determining the solid/stacked, weight/stacked and charcoal conversion factors for important firewood species in the Punjab.

Charcoal.—Measurements for conversion factors were taken for *Dalbergia sissoo* firewood at Chichawatni.

III.—Miscellaneous.

Rainfall statistics.—Rainfall statistics were maintained in the Silvicultural division.

Photographic collection.—The total number of prints in the collections was 1,358 including 58 added during the year.

The collection of lantern slides stood at 122, 13 being new additions.

Records.—With the addition of 17 specific and 35 general ledger files, the number of current files stood at 120 specific and 298 general.

Library.—The Punjab Forest Library was maintained by the Silvicultural Research division.

Working Plans.—6 working plans and 3 working schemes were sanctioned while one working plan was under preparation.

UNITED PROVINCES.

I.—Experimental silviculture.

(i) *General.*

The instructions regarding experiments and the annual silvicultural report mentioned last year have worked well. An enquiry from another province leads us to hope that the present procedure in the United Provinces may be usefully applied elsewhere.

Of the 34 divisional experiments in existence at the beginning of the year six have been closed and final reports written. Two experiments have been added during the year.

The Silviculturist's sanctioned experiments increased from 64 to 68. Work has been stopped in sixteen of the above experiments and the only reason they are not formally closed and excluded from the list is that the final reports are not complete.

(ii) *Natural Regeneration.*

(*a*) *From seed.*

Shorea robusta (*sal*).—There is practically nothing to report on natural regeneration of *sal*. The first four big lay outs for a detailed study of natural regeneration of *sal* are now fully organised. They comprise 48 sub plots under different treatments with a total of 96 indicator lines. The other new *sal* experiments of the same series were under felling at the close of the year. An experiment of intensive weeding of *sal* regeneration in existence but which had hitherto failed to grow up, was started during the year, but it is much too soon to say

anything more. To sum up, nothing can be added to what was written last year. We do not know how to induce *sal* seedlings to survive; all we can say is that if *sal* regeneration exists in the whippy stage, a combination of clearfelling and shrub cutting in a deer proof fenced area definitely benefits *sal* regeneration more than merely a heavy felling or no felling without shrub cutting. One other point definitely proved is that the taller seedlings respond very much better to the treatment than the smaller seedlings.

(*b*) *From coppice.*

Shorea robusta (*sal*).—The Divisional Forest Officer, North Kheri division, reports that young *sal* coppice in deer proof fenced areas has all benefited with protection from browsing, and as would be expected the lighter the canopy the better the result. Regeneration of *sal* by coppice really presents no serious difficulties. Provided there are sufficient young and healthy stools, it is perfectly certain that good coppice will be obtained. If this is in an area where frost damage is severe, a frost protecting overwood removed at judicious intervals allows a healthy young crop of *sal* coppice to grow up; if on the other hand browsing damage is excessive it is perfectly easy to get a healthy young crop inside a deer proof fence.

Acacia arabica (*babul*).—*Babul* coppice in Etawah shows steady growth, but mortality now is about 40 per cent. of trees originally coppiced in January, 1931. The Divisional Forest Officer, Afforestation division, reports that while the coppice is promising in all areas, the trees coppiced are only 3″—5″ diameter.

Hill oaks.

Quercus incana (*banj*).—It is apparently comparatively easy to coppice. The plots show survivals of 40 to 60 per cent. of all shoots (which is quite sufficient) while the average height in five years may be 3·9″ to 5·8″ depending on altitude, etc.

Quercus dilatata (*moru or telonj*).—This apparently is not a good coppicer. The Kilberry plot, 7,000 ft. high, shows only 20 per cent. shoots surviving after five years and the average height only 1·7″.

Quercus lanuginosa (*rianj*).—Apparently a good coppicer. The Kilberry plot at 7,000 ft. has nearly 60 per cent surviving shoots after five years and average height of 3·8″.

(iii) *Seeds.*

The United Provinces seed store continued to function at Clutterbuckgunj as a distributing agency for seeds of all sorts, especially teak.

Germination tests were carried out of all seeds after various periods of storage under ordinary conditions.

(iv) *Nursery Work.*

There is little of general interest to report. The electroculture experiments have been completed and records are under compilation. They show that X-ray and high tension spark treatment of seeds have a slight stimulating effect, but that the electrolytic treatment given had a definitely injurious effect. The so called " radio-magnetic " nets and jackets, said by Dr. Nehru to have very stimulating effects, appeared to have no effect at all, either on germination of seeds or on the development of seedlings and coppice shoots; nor did the jackets afford any protection from injury by frost.

(v) *Artificial Regeneration.*

Artificial regeneration by *taungya* is becoming increasingly important all over the province. The only slightly interesting thing which may be mentioned is that in the Haldwani experiment of *sal* artificially regenerated with lines of *boga*, frost damaged the *sal* seedlings in a neighbouring area where *sal* was growing among cotton, but in the *boga* area although frost killed the *boga*, the *boga* apparently protected the *sal*.

Tectona grandis (*teak*).—The All India Teak Seed Origin experiment in the Gorakhpur division developed well although owing to bad seed germination the plot for Central Provinces teak is still not quite completely filled. The parallel experiment in Lakhmanmandi in the Haldwani division was again affected by frost and the whole had to be cut back for the third time. Lakhmanmandi was formerly regarded as free from frost and divisional teak plantations have been raised successfully there in the past five or six years. Extensive fellings for experiments and plantations appear now to have created a frost hole.

Bombax malabaricum (*semal*).—It is definitely proved that *semal* can be easily raised from cuttings provided porcupine can be kept out. The porcupine is extremely fond of *semal* and can easily demolish a whole plantation; nor is it easy to protect against porcupine. Out of 12 sub plots in the Dolpokhra experiment only two have so far completely resisted all attempts at porcupine entry, four have been slightly damaged and six seriously damaged. Porcupines get in either by burrowing under the wire, cutting through it, or climbing over it.

Ischaemum angustifolium (*baib grass*).—Reports on the cultivation of baib grass seem to vary. The Silviculturist manages to make it succeed on *bhur* (sandy soil in the plains). The Divisional Forest Officer,

Afforestation division, is getting four to five maunds per acre of *baib* from plantations put out 2′ by 2′ in 1929. The Divisional Forest Officer, Gorakhpur, however, reports that even under the conditions of an abandoned teak nursery, the *baib* failed completely on rather stiff soil, although in two other areas the results obtained were more promising. He however considers it quite uneconomical to attempt to introduce *baib* grass on a large scale in areas already occupied by other grasses. He considers it expensive and that the other grasses would eventually oust the *baib* grass. The results are not conclusive as they were based on experiments on quite small areas. The Divisional Forest Officer, Pilibhit division, on the other hand seems to report favourably, both as regards ease in formation and the yield. No final conclusions can yet be drawn.

(vi) *Reclamation and Afforestation.*

Usar (*saline soil*).—The experiment at Mukhdumpur between Lucknow and Cawnpore has not yet attained a stage when any final report can be written. Unfortunately the area suffered from the poor monsoon of 1933, which rather held up the progress of the experiment.

Bhur (*riverain sand*).—The afforestation experiment at Ujhani has succeeded and no further dying of the larger *khair* trees occurred from frost. The dying reported last year was probably due to the fungus *Ganoderma lucidum*, but the Mycologist is not prepared to say definitely what part the fungus plays in the mortality of *khair* till the results of the experiment are complete.

The afforestation of *bhur* at Kanjhera (Lucknow) suffered again from the extreme heat and unfavourable monsoon in 1933 and a very severe frost in January, 1934. Practically everything was killed back to the ground. Although certain species like *khair*, *siris*, etc., are giving out new shoots, it appears that all attempts to afforest the area are likely to end in failure. The combination of extreme heat and drought in summer and severe frost in the winter is too much for most species. With a favourable season or two *khair* and *sissu* might succeed, but baib grass seems to offer more promise.

The ' fuel next door ' scheme at Faridpur (Bareilly) has not succeeded in its primary object, namely to raise a village forest by *taungya* by villagers. The land, which is a poor sort of *bhur*, cannot yield a paying crop even rent free. The area is being maintained as a *bhur* experiment.

Afforestation of chandars by taungya.—A large experiment is in progress in the Pilibhit division and so far some 85 acres is under *taungya*. It is too early to give any report on this.

(viii) *Mixtures.*

It is reported from the Gorakhpur division that *Ougenia dalbergioides* in *taungya* has been found a suitable companion for *sal* in the early stages, whereas *Pterocarpus marsupium* grows too rapidly and tends to suppress *sal.*

(xi) *Miscellaneous.*

Biennial departmental burning in Nagwa block of the Gorakhpur division was done to improve the quality and quantity of the grass. The conclusions from the experiment were that no permanent improvement resulted from the biennial burning though a temporary decrease in thorny bushes and coarse grass was noticeable in the season immediately following the burn.

Departmental burning of the moist type of *damar* areas between Dudwa and Tiger Well in the North Kheri division was done for the fourth successive year. The Divisional Forest Officer reports that climbers, *rohini* and other miscellaneous species of the understory and evergreen under-growth have been much reduced and the burnt areas afford a marked contrast to the unburnt adjoining areas where under growth is still dense. He also reports that in the burnt area *Clerodendron* has increased to an undesirable extent.

Resin tapping.—The very large resin tapping experiments near Garhkhet in the West Almora division were tapped according to the plan throughout the 1933 season and tapping was recommenced at the beginning of March, 1934. The summer of 1933 was exceptionally cool and wet and the resin yield was considerably less than normal in the ordinary divisional work. Obviously no conclusions can be based on one year's work, more especially when that year was a very abnormal year climatically. So long however as it is fully realised that no conclusions can be based on the experiments, there is no harm in recording what has been observed. Taking the average yield of resin per 100 channels for the three straight grained experiments, the shallow tapping gave the most yield, the deep tapping the next and the medium tapping the least yield. The average yield for the three experiments in twisted crops gives the same results. The above are averages. There are individual variations between the experiments. Thus, out of the six, three show the greatest yield with the shallow tapping, one with medium tapping and two with the deep tapping; but where the yield from the medium and the deep tapping is greatest the excess over that from the shallow tapping is slight, whereas in the experiments with the greatest yield from the shallow tapping, the excess over the yield from the other depths is considerable.

II.—Working Plans and Statistics.

(i) *Working Plans.*

The following working plans were completed during the year :—

1. Banda.
2. West Almora.
3. Gorakhpur.
4. Tarai and Bhabar Estates.
5. Naini Tal Cantonment forests.
6. Government House Forests.

(ii) *Yield Tables.*

Permanent sample plots.—Sixty-six permanent sample plots were measured during the year. Certain United Provinces plots were kindly measured by the staff of the Central Silviculturist to enable the provincial statistical party to lay out new linear sample plots in the hill *sal* areas of the Ramnagar and Kalagarh divisions.

Linear sample plots.—Ten linear sample plots, one chain wide, with a total length of a little over thirteen miles were laid out in the Moist Siwalik and the Dry Siwalik hill *sal* forests of the Kalagarh and Ramnagar divisions. The object of the plots is statistical research in irregular *sal* forests of the selection type.

Increment of tapped and untapped chir trees.—The Divisional Forest Officer, West Almora, suggested that the yield tables for *Pinus longifolia* compiled chiefly from untapped trees or trees in which tapping had for many years been stopped, would not be applicable to normal crops which are regularly tapped for resin. Accordingly an investigation was carried out in the West Almora and Naini Tal divisions in II and III quality *chir* forests by analysis of sections at 4½ ft. and 15 ft. height of 100 trees. The data are still under analysis, but the results so far obtained for III quality *chir* indicate that tapping causes an increased diameter at 4½ ft. height, *i.e.*, where the tapping actually takes place, but a decreased diameter increment at 15 ft. height, *i.e.*, above the limit of tapping.

III.—Miscellaneous.

There is little of extra provincial interest to report under this head. Ledger filing continues as a routine matter. The Chief Conservator of Forests' library has been completely rearranged and brought up to date. This brings to a successful conclusion a task that has occupied a succession of officers for the past three or four years.

CHAPTER III.—FOREST BOTANY.

ASSAM.

I.—Oecology.

A second collection of grasses and also of woody plants and herbs of importance from the *sal* (*Shorea robusta*) forests of Goalpara has been made and identified in order to assist oecological investigations.

An intensive study of all vegetation in some of the *sal* experimental plots of that division has also been started with the same objects in view.

II.—Systematic.

The following ten species of flowering plants are recorded as addition to the Flora of Assam, of which *Pachylarnax pleiocarpa* has been described by Mr. J. E. Dandy of the British Museum in the Journal of Botany, November 1933, the remaining nine plants have been described and are shortly being published as new to science :—

1. *Pachylarnax pleiocarpa Dandy.*
2. *Eurya japonica, Var. nitida forma Kanjilalii Debbarman.*
3. *Sterculia khasiana Debbarman.*
4. *Gymnocladus assamicus U. N. Kanjilal.*
5. *Lagerstroemia minuticarpa P. C. Kanjilal.*
6. *Agapetes Kanjilalii Das.*
7. *Maba cacharensis Das et Kanjilal.*
8. *Symplocos Pealii King.*
9. *Chirita mishmiensis Debbarman.*
10. *Strobilanthes furcatus Biswas.*

Two species of *Lauraceae* (i) *Kaula* (Nowgong), (ii) *Mekuhi* (Sadiya) and one species of *Myrtaceae* are still under further investigations and it is quite likely that they will turn out to be species new to science.

The work of collecting materials for a detailed study of *bonsum* (*Phoebe*) of Assam has now been completed; detailed examination of the available materials is in progress and it is expected that these investigations will reveal many interesting facts.

It would be of some academic interest to note here that *Abies delavayi* has been recorded from Piri Hills (Balipara Frontier Tract) 10,000 ft. (Dr. N. L. Bor). There is also a new record of *Sapria himalayana* from Khasi Hills.

The forest Herbarium has been maintained in good condition. Over 3,000 sheets have been mounted during the year. Replenishing of the Herbarium with new collection has been continued and over 500 specimens have been added during this year bringing the total to about 20,500.

A further contribution of about 300 sheets has been made to the Cotton College, Gauhati, since the submission of the last report. Requisitions from other institutions and herbaria have been received and they have been met as far as practicable.

Specimens and seeds of *Chirita* and *Didymocarpus* have been supplied to the Director, Royal Botanic Garden, Kew.

III.—Pathology or Plant Diseases.

Two specimens of hard fungi were collected by the Silviculturist, one growing on dead *nahor* (*Mesua ferrea*) and the other on dead *hollong* (*Dipterocarpus macrocarpus*). The former has been identified as *Fomes dochmius* and the latter as *Fomes applanatus*. Their pathogenecity is being investigated by the Forest Mycologist at Dehra Dun.

A *Loranthus* sp. has so extensively invaded the *gomari* (*Gmelina arborea*) crop (artificial) in Bhanugach reserve, Sylhet division that any control measures undertaken to exterminate the pest would appear to be uneconomic.

IV.—Publications.

The manuscript for the " Flora of Assam " is now ready up to *Apetalae*. Unfortunately the selection of reliable printers took an unusually long time and definite settlement was arrived at with the new printers only at the end of the year. Printing work is now progressing satisfactorily and the first volume (Part I) (*Ranunculaceae* to *Moringaceae*) which is now with the printers will it is hoped be put before the public by the middle of the ensuing year.

Assam Forest Records (Botany) Vol. I with the title of " Some new species of Assam " in which detailed descriptions of the plants are embodied has been sent to the printers and is expected to be published in July 1934.

BIHAR AND ORISSA.

Pathology.—Fungal attacks were found killing *sal* in Angul and Saranda. The *sal* root fungus *Polyporus shoreae* was identified.

In the Barunai and Ankola plantations of Puri division some teak were found dying. Death was apparently due to a fungus that appears as a whitish-grey mycelium in the bark and cambial layer. Specimens

were sent to the Forest Research Institute but so far the Forest Mycologist has been unable to identify it or grow cultures. This fungus will be kept under careful observation.

BURMA.

Staff.—The post of Forest Botanist remained unfilled. Mr. R. W. V. Palmer, I.F.S., held charge of the office throughout the year in addition to his own duties as Silviculturist. Maung Kan was Curator throughout the year.

Herbarium.—The herbarium was generally maintained in excellent condition. Over 1434 sheets were mounted during the year thereby bringing the total to 37,816 sheets in the herbarium at the close of the year. A considerable number of partially named Burmese grass specimens were sent to Kew and Dehra Dun for naming. About 4 sheets of *Anisoptera* sp., and 10 sheets of *Vatica* sp. were sent on loan to the Forest Botanist, Forest Research Institute, Kepong, Federated Malay States, who is making a systematic revision of some of the Malay Peninsula species. In addition to this 5 sheets of *Scolopia* sp., 8 *Shorea* sp. and 10 *Dillenia* sheets were sent on loan to the Forest Botanist, Forest Research Institute and College, Dehra Dun.

Presentations to the herbarium.—We are especially indebted to the Regius Keeper, Edinburgh, for the very valuable collection of 40 *Primula* specimens supplied by him. These were collected by Mr. G. Forrest on the Burma frontier.

In addition we are also indebted to Mr. C. F. Symington, Forest Botanist, Forest Research Institute, Kepong, Selangor, Federated Malay States, for the valuable gift of 100 sheets of *Dipterocarpaceae.*

Collection.—About 2,000 specimens remain to be mounted, and another 200 specimens were received from the Forest Botanist, Forest Research Institute and College, Dehra Dun, and were mounted and added to the herbarium. The additions were largely from the last year's collection of the Forest Botanist and his staff.

Contributions were also received from the following:—

Brigadier C. C. Foss, V.C., D.S.O., Maymyo.

Mr. R. W. V. Palmer, Silviculturist, Maymyo.

Mr. D. J. Atkinson, Forest Entomologist, Maymyo.

Mr. C. E. Parkinson, Forest Botanist, Dehra Dun.

Mr. H. E. Flint, Divisional Forest Officer, Myitkyina.

Mr. A. Long, Divisional Forest Officer, Taunggyi.

Distribution.—Duplicate specimens were distributed to the following Institutions during the year as follows:—

(i) Forest Research Institute and College, Dehra Dun, U. P., India ..	540
(ii) Royal Botanic Garden, Kew	101
(iii) Royal Botanic Garden, Sibpur, Calcutta	178

Identification.—During the rainy season most of the Curator's time was occupied in mounting, writing up labels and examining the previous collection of about 2,000 specimens. The majority of these specimens were named at Maymyo, and after mounting and treating with preservative they were added to the herbarium. Specimens were also sent to other herbaria for comparison and naming. In addition to the above a fair amount of identification work was also carried out locally.

Research.—In the Kew Bulletin of Miscellaneous Information No. 7 of 1933 the eleventh contribution to the Flora of Burma is made by Mr. C. E. C. Fischer of the Kew Herbarium. Nine plants are newly reported from Burma or their range in Burma extended and one species, *Palaquium sukoei* C. E. C. Fischer, is described as new to science.

CENTRAL PROVINCES.

I.—Ecology.

The botanical survey of the plants found in the Betul division was continued and up-to-date some 600 species have been identified. One of the most striking facts that have come to light is reported to be the extreme poverty of the *Orchidaceae*. Mr. George, the Divisional Forest Officer, Hoshangabad, continued his studies of the plant life of Pachmarhi and his work will be of value in the revision of the *flora* section of the Guide to Pachmarhi, which is now under preparation.

II.—Systematic.

At the request of the Forest Botanist, various botanical specimens were sent to Dehra Dun for examination.

III.—Pathology or Plant Diseases.

The fungus, *Fomes pappianus*, is still a serious pest in all the older *babul* (*Acacia arabica*) plantations in the West Berar division.

CHAPTER IV.—FOREST ENTOMOLOGY.

ASSAM.

B.—Economic Entomology.

2. *Miscellaneous Investigations and Records.*

In Sylhet *gomari* (*Gmelina arborea*) plantations were attacked by *Dihammus cervinus* and *poma* (*Cedrela*) by *Hypsipyla robusta*. In Kamrup the flowers of *sal* (*Shorea robusta*) were attacked by larvae of *Geometridae*. In Sibsagar, *hollock* (*Terminalia myriocarpa*) was damaged by an insect, probably a species of *Indarbela* (a bark-eating caterpillar) judging from samples of injured stem examined by the Forest Entomologist. Specimens of damaged *ajhar* (*Lagerstroemia flos-reginae*) were sent to the Forest Entomologist and were found to have been attacked by *Phassus* species (*Hepialidae*).

BIHAR AND ORISSA.

Defoliation by *Hyblaea puera* and *Hapalia machaeralis* was very severe in the Angul and Puri teak plantations. In some places attack was associated with the killing of leading shoots while production of epicormic shoots was stimulated. It is probable that the severity of these attacks was stimulated by heavy showers in April and May which caused an early flush of leaves. The defoliation in these areas is under investigation by the Forest Entomologist.

BURMA.

A.—Pests of Teak.

1. *Xyleutes ceramica* Wlk., the Beehole Borer.

(*a*) *Life History.*—For the first time an individual has been reared from egg to adult. This is the insect referred to in last year's Annual Report as surviving in the Zibingyi cage from the 1932 brood—the eggs were laid between March 30th and April 2nd, 1932, and the sole survivor, a male moth, emerged on April 2nd, 1934, a clear case, therefore, of a two years life cycle.

As it has not proved possible to start new broods *ab initio* three cages, at Thogale, Zibingyi and Maymyo, were stocked with young larvae, about 6 weeks old, in June 1933. Of these ten larvae survive (June 1934) in the Maymyo cage, the two other cages being less successful. Two adults from these 1933 larvae emerged, one from the Thogale, one from the Maymyo cage, instances of a capability to complete development in one year.

A few freshly emerged female moths were captured, mating was achieved, and a new brood has been started successfully in the Thogale cage. Oviposition habits were again observed, and details previously recorded were confirmed. Support was obtained also for the suggestion made in a previous report that normally the female moth probably lays the great majority of her eggs under creepers and in partly occluded old beeholes or other similar deep fissures, in which she can bury the ovipositor to its full extent. A piece of board was nailed to the tree on which the ovipositing female was engaged—until she came to it very few eggs had been laid, none of the normal bark fissures being to her liking—immediately on finding the piece of board, however, she inserted the ovipositor, commenced egg-laying, and continued for some 20 minutes, when a large mass of eggs was just visible between board and bark.

Life History Observation Plots.

1932 attack.—Of the 50 larvae which entered their 2nd year at the beginning of the 1933 rains only 26 survived in June, 7 in September and 3 in January 1934, and only one moth emerged (on March 21st). This, with the 4 moths that emerged last year after only one year in the pre-imaginal stages, gives a total of five moths as the result of the 1932 attack over one acre of one of the most heavily beeholed forests in Burma.

1933 attack.—When first enumerated, between June 20th and 24th, the plot showed 277 beeholes, the smallest number ever recorded for the new attack. As noted last year, however, the original figures for the new attack have little significance, as at this stage the larvae wander a great deal, and a difference of a week or so in date of enumeration may result in a wide difference in numbers. When the Plot was next visited, in August, only 130 of the original 277 survived, but a further 274 new beeholes were recorded—in September 217 previously recorded larvae survived and 83 new ones were ringed;—by November the survivors numbered only 182, but even so late as this a further 36 new attacks were recorded. Further visits showed a gradual reduction in the number of survivors, until in April 1934 only 54 were still showing signs of activity, and pass into their second year.

The constant occurrence, up to November at least, of previously unrecorded beeholes is an indication of the wandering habits of the larvae—a definite instance was noted on November 17th, when a larva of normal size for an age of six months was taken in a previously unrecorded bechole, so fresh that it had only just reached the surface of the sapwood.

The fact, however, that in August there was a larger total number of larvae in the plot than when originally enumerated in June indicates

that either the moth emergence period is considerably longer than we have previously thought it, or that the young larvae spend several weeks tunnelling about in the bark before commencing the beehole proper, with ejection of appreciable frass to the exterior—it is not, of course, until this latter event occurs that the presence of the larva is discoverable. It is considered that the latter is the more probable of the two possible explanations. Such indications as we have are that the moth emergence period does not extend over much more than six weeks in any given locality, whereas several instances are on record of young larvae spending two to three months boring about in the bast, without penetrating to the sapwood, and ejecting appreciable quantities of frass.

Again, as in previous years, the 1933 attack produced a few moths, 5 in all, during March and early April, almost certainly instances of a one year's life cycle, the fairly frequent occurrence of which must now be accepted as proven.

(*b*) *Analyses of past attacks.*—The comprehensive survey of beehole conditions throughout the Province, envisaged in last year's Annual Report, was sanctioned during the year, and is now in progress, the writer having been relieved of his territorial charge in October 1933. Some 15 Divisions, in fact the greater portion of the Province in which planting operations have been, or might be undertaken, are included in the area to be covered by the survey, and the work is being jointly carried out by the Forest Economist and the writer, the former dealing, by mill analysis in Rangoon, with the more accessible plantation areas, and the latter, by hand analysis in the forest, with the less accessible areas, from which extraction would be unduly expensive, and with areas in which more detailed biological investigation seems indicated.

Hand analyses in the following localities have been carried out, the assistance of Mr. D. P. Greenep, Deputy Conservator of Forests, being fortunately obtained for the four analyses in Magwe and Allanmyo. The localities are tabulated below in ascending series for beehole incidence, the last column showing estimated annual rainfall.

Division.	Reserve.	Age.	Beehole incidence per 100 tree years.	Estimated Rainfall.
				Inches.
Meiktila . . .	Kubyin . . .	P. 11 . . .	*Nil.*	60
Ttaran	Kyunchaung . .	P. 43 . . .	·36	175
Allanmyo . . .	Kayinmasan U. C. F.	N. 24 (average) .	1·9	45

P. = Planted. N. = Natural.

Division.	Reserve.	Age.	Beehole incidence per 100 tree years.	Estimated Rainfall.
				Inches.
Magwe	Kalama U. C. F. .	N. 54 (average) .	6·7	45
Do. . . .	Obauk U. C. F. .	N. 49 („) .	10·9	45
Do. . . .	Kyaukmigyaung, C. 80	N. 44 („) .	18·5	45
Mu	Nanhlaing . .	P. 14 . . .	20·0	70
Pyinmana . . .	Palwe, C. 105 . .	N. 47 (average) .	20·5	60
Yamethin . . .	Ngalaik . . .	P. 28 . . .	24·1	60
Katha	Pile P. . . .	P. 16 . . .	53·9	60
Pyinmana . . .	Kaing . . .	P. 21 . . .	109·3	60
S. Toungoo . . .	Pyuchaung . .	N. 78 . . .	153·2	90
Thaungyin . . .	Meple . . .	P. 40 and 30 . .	345	85

P. = Planted. R. = Rainfall.

It will be observed that, with few exceptions, rainfall follows beehole incidence, also in an ascending series—it should be noted, however, that with the single exception of Meple, where a Forest Department rain gauge is maintained, the rainfall figures are merely those estimated from the nearest official recording station, and may be entirely misleading when applied to localities within the forest.

The unexpectedly high incidence in a Kaing Reserve plantation, Pyinmana, is distressing, and it is of particular interest that this figure so greatly exceeds those for neighbouring localities, Palwe (20·5) and Ngalaik (24·1) only a few miles distant, as also that for another plantation near Nganzat, the incidence in which, analysed by the Forest Economist, is in line with those of Palwe and Ngalaik. Such rapid variation in incidence demands further investigation and it is proposed, therefore, to carry out a series of analyses in the neighbourhood in the hope that some clue may emerge as to the controlling factors.

South Toungoo now yields pride of place to the Thaungyin as the worst known area for beehole in the Province. The index figure implies that the average plantation tree will at maturity contain between 300 and 400 beeholes (these figures exclude the minor blemishes of feeding scars) and be so riddled as to be worthless.

In addition to the above analyses advantage was taken of the availability of a number of lessees' rejected logs from Compartments 97 and 98, Minbyin Reserve, Pyinmana, the next regeneration centre to be opened under the Pyinmana Working Plan, to have 30 of these logs sawn in a local mill and to analyse them on the Rangoon standard. The incidence of beeholing in these logs worked out to 7·4 per 100 square feet of 1″ boards, which indicates a reasonably light degree of beeholing, and is in line with other figures for Pyinmana timber.

(c) *Natural enemies.*—Analysis of beehole incidence in a 1919 plantation in Nanhlaing Reserve, Mu division, revealed an exceptionally high rate of parasitism by an undetermined ichneumonid, amounting to 35·8 per cent. The incidence of parasitism, either hymenopterous or dipterous, is usually extremely low, and in only one other case has even combined parasitism been found to exceed 10 per cent.—in that case the figure was 10·9 per cent. Unfortunately no living parasites were taken, in fact there was no case of parasitism of the current year, so that it was not possible to judge at what time of year the parasite kills its host and reaches the adult stage.

II.—Defoliators.

No extensive defoliation was either reported by Divisions or discovered by the staff, the few reports received having reference to minor defoliation by *Hyblaea puera* Cram. as usual early in the rains. No reports at all were received regarding *Hapalia machaeralis* Wlk. the usual agent of serious defoliation.

Hapalia machaeralis Wlk. The generation series of this insect has continued without break, fourteen generations being passed through between 23rd March 1933 and 11th April 1934. In the field also the insect was taken in some stage in every month of the year. No alternate host has yet been discovered in Burma, though Dehra Dun now records *Callicarpa arborea* and *C. macrophylla* as alternate hosts.

Machaeralis is certainly able to maintain itself throughout the year on teak alone, depending during the normally leafless period on odd coppice shoots, etc., and in consequence suffering a heavy annual diminution in numbers at this time of the year.

Hyblaea puera Cram. Here again the species ran through an unbroken series of fourteen generations between 19th March 1933 and 31st March 1934. Though there was no difficulty in rearing the insect in the Insectary during the cold weather, no greater difficulty, that is than is always experienced with this delicate species, it was again found impossible to take it in any stage in the field between mid-December, and the end of March. It seems probable that in the case of *puera* which hibernates as an adult where this occurs, the moth will lay its eggs if suitable foliage is available and thus carry on the generations without a break, if not will conceal itself until such time as foliage, probably of some host other than teak, again becomes available. The species thus avoids the annual reduction in population suffered by *machaeralis*, which, hibernating as a larva, seems to be entirely controlled by climatic conditions, and where these do not permit of a seasonal diapause, must necessarily lose the greater portion of its population annually. This point with regard to *puera* requires further investigation.

III.—Other Pests of Teak.

Dinoderus ocellaris.—This bostrychid, though a pest of bamboos, is included here as it achieved unpleasant notoriety last year as boring trial galleries in converted teak under shipment to European ports. As proposed in last year's report experiments have been undertaken at the Government Timber Depot, Ahlone, to show whether and to what extent submersion in water will render bamboo (dunnage) less susceptible, if not immune, to the attacks of this beetle. Though the experiments are not yet complete they have already indicated that soaking in water has a definitely deterrent effect.

Pari passu with these experiments has gone a series of analyses of the starch and sugar content of the bamboos, kindly carried out by Professor Peacock of Rangoon University. These have been most interesting and have shown a rapid diminution of the sugar content resulting from the soaking, the quickest disappearance, as might be expected, occurring in the case of the material soaked in running water. Conversely the starch content has shown an apparent increase, probably due to the disappearance of the soluble sugars causing the insoluble starch to form a larger percentage of the residual weight. These results seem to indicate that it is the sugars that form the attractive constituent of the bamboo, and that liability to attack by the borer should be least when the sugar content is at its minimum. We have not as yet enough information to say when this condition obtains in Burma—in Dehra Dun it is said to occur at the break of the rains, when the bamboo is immune from attack. It would be of considerable scientific interest to follow up this point, though if it can be shown that the soaking of susceptible bamboo renders it immune from attack, this result is probably of more practical significance, as permitting contractors to fell at any time of the year.

B.—Pests of other species of economic importance.

Calopepla leayana Latr. Defoliation by this insect in the *Gmelina arborea* plantations at Namtu did not occur to any extent during the year. As before, experience was that the beetle first appeared along the edges of the outermost plantations lying contiguous to the jungle, having come in from its hibernation quarters under the bark of dead trees, etc. It may be recalled that in 1932 no widespread second generation materialised, and as a result the beetle appeared this year in smaller numbers than usual.

The routine control measures were carried out, and 17,000 resting adults were collected and destroyed during the period 20th April to 20th May. During the following month, after the appearance of the

active adults, a further 266,000 were hand-picked, and egg masses destroyed where practicable.

An assistant visited the plantations during July, and found defoliation to be slight, only around the edges, and complete in few places. The greater portion of the population was then in the pupal stage (of the first generation of the year) and parasitism by *Brachymeria* sp. amounted to 37 per cent. Thereafter the population dwindled, and with it defoliation—by September there was practically no sign of the insect and the trees were in full foliage.

At the beginning of the cold weather appreciable numbers of the beetles were found in several of the artificial traps, though, as noted previously, only in the uppermost compartments. This has encouraged the Division to experiment this coming cold weather with taller traps, which should be, if possible, above or level with the crowns of the trees.

The chalcidoid egg parasite referred to in last year's report (unidentifiable at Dehra Dun) was taken at Namtu during the year. Its life history has been worked up in the Insectary, and it was found that under favourable conditions the complete life cycle from egg to adult occupies only 8—9 days. We have not succeeded in carrying the parasite through the winter, but it is clear that it passes this period as a resting adult, as adults of the last bred generation lived for a maximum period of 102 days, whereas the normal expectation of adult life is 20—30 days. A curious characteristic of this insect is the apparent absence of the ovipositor during the first few days of adult life—the female does not extrude the ovipositor until the 3rd or 4th day.

The proctotrypid egg parasite of *Aspidomorpha miliaris*, an allied cassidine, was successfully received from the Federated Malay States, but was found to be of no value. Though the parasite accepted *Calopepla* egg masses and attempted to oviposit therein, successful development occurred in very few cases, only 2 adults being reared. The ootheca of *Calopepla* is of a different type to, and of much firmer construction than, that of *Aspidomorpha*, and is obviously unsuitable. In any case, as we have now discovered an endemic egg parasite, the introduction of a foreign parasite is no longer so desirable, and might conceivably have been actually undesirable.

To insure the maintenance of the stock of proctotrypids, until such time as experiments with them as parasites of *Calopepla* had either succeeded or failed, a number of pupae of the natural host, *Aspidomorpha miliaris*, were also imported from the Federated Malay States. Though Burma should be within the range of this species it was not known where it could be obtained in numbers, and in fact the Agricultural Entomologist reports it as unrecorded in this country. As it was easy to obtain specimens from the Federated Malay States this was

done, and the dozen or so specimens received alive have propagated here without difficulty. Though the species has not actually been used yet for the purpose for which it was obtained, and for which there now seems to be little necessity, it shows promise of being perhaps of great value as an alternate host for *Brachymeria* sp., the important pupal parasite of *Calopepla*, and possibly also, as an alternate host for *Calopepla's* egg parasite. As has been noted annually there is the greatest difficulty in carrying *Brachymeria* over the resting period of its host, which is greatly prolonged, and the annual mortality of the parasite in Nature must be enormous. *Aspidomorpha*, however, has shown a definite tendency to resume activity far ahead of *Calopepla* the first adult of the first generation of the former appearing this year one day before the first egg mass of the latter. Larvae of *Aspidomorpha* in the required pre-pupal state were in consequence available before the over-wintering adults of *Calopepla* had even resumed activity. Though opportunity has not yet arisen to try it, it is thought highly probable that *Brachymeria* will successfully parasitise the prepupa of *Aspidomorpha*—if this be so, host material in abundance could be provided for the parasite a month or more before its natural host would be available, so that by the time the latter appeared there would be a vigorous population of the parasite ready to deal with it. Experiments on these lines will be put in hand as soon as material is available.

The expectation that *Brachymeria* will successfully adopt *Aspidomorpha* as a host arises from the fact that it has shown itself ready to attack without hesitation the prepupae of another cassidine, *?Prioptera* sp., a defoliator of *Ipomaea bona-nox*, which has been bred in the Insectary for the past two years. The parasite oviposited readily in this host, although it is very considerably smaller than either *Calopepla* or *Aspidomorpha*, and 5 adults emerged in due course. All were males, and much smaller than the normal adult reared from *Calopepla*. Several failed pupae were opened and found to contain the shrivelled remains of the parasite maggots. It appears probable, therefore, that it was only the very small size of the pupa which prevented parasitism being normally successful, and that this should succeed in the case of *Aspidomorpha* where the pupating larvae and pupae are approximately the same size as those of *Calopepla*.

Experiments will also be run to see whether *Aspidomorpha* can act as an alternate host for the egg parasite of *Calopepla*.

Xyleutes persona Le G. Breeding experiments with this species on *Cassia fistula* continue at Pyinmana. Nine larvae from eggs laid on 20th September 1932 still survive, indicating a life cycle of at least two years. An interesting occurrence was the emergence of a male moth

ex a caged tree on 27th December 1933,—this tree was caged in September 1931, when the larva was already in the tree, and thought to be then about a year old. Though by no means a clear case, it seems that this species may extend its larval life to three years.

Also remarkable is the extremely late date of emergence of this specimen. Last year emergence was noted as occurring almost throughout the rains—the same was experienced this year, with the period extended a full two months by the above specimen.

Though 23 moths were obtained during the year, amongst which six were females, successful mating was unfortunately not achieved although one pair coupled for three hours.

CENTRAL PROVINCES.

Arrangements were made during the year for a party from Dehra Dun to visit the Seoni, Jubbulpore, and Saugor divisions, to study insect damage in the teak forests, especially defoliators in coppice areas.

1. *Specific Investigations.*

(*a*) *Hoplocerambyx spinicornis.*—The *sal* borer is reported from several divisions but its attack is no longer epidemic. In the Balaghat division 13,043 beetles were caught and destroyed on trap trees during the swarming period June-July 1934, and attacked trees were felled and stacked and subsequently burnt in the hot weather. In the Bilaspur division, 138 trap trees were felled and 5,171 beetles were caught and destroyed.

(*b*) *Hapalia machaeralis.*—The abnormally heavy early rains during the hot weather of 1933, appear to have been responsible for a very severe attack of this teak defoliator in many divisions. In Nimar, Yeotmal, Nagpur, West Berar, Jubbulpore and Betul in particular, this pest has caused serious damage, especially in coppice coupes, where many leading shoots have been killed. A report was made to the Forest Entomologist who arranged to send a party to investigate. The poor seeding of teak during the year is attributed to the severity of the epidemic. The damage in Betul is reported to be most severe where teak is found pure.

(*c*) *Tonica niviferana.*—Almost all *semal* (*Bombax malabaricum*) seedlings in the Cherbaoli plantations in the Nagpur Wardha division are suffering from attacks of the *semal* bud worm.

(*d*) *Celosterna scabrator.*—This borer continues to do serious damage to the *babul* plantations in the West Berar division.

3. Unclassified or Unidentified Damage.

No important new unidentified pests are reported. In the Jubbulpore division, the larvae of an unidentified *cerambycid* beetle are doing some damage to young poles of *tendu* (*Diospyros melanoxylon*).

C.—Forest Zoology.

In the West Berar division, herds of wild cattle which infest many of the *babul bans* continue to do serious damage in plantations and in the adjoining cultivation. Their numbers are said to be increasing by breeding and by the addition of stray cattle from the village herds. Efforts to reduce their number by catching in stockades and by lassooing have only been partially successful.

In the *sal* forests of the Supkhar range in the Balaghat division experimental plots were laid out during the previous year to investigate to what extent the large herds of deer are responsible for the failure of *sal* regeneration. In the fenced areas the growth is now incomparably better than in the unfenced, where almost every shoot has been browsed back. It is clear that the damage done by deer is far greater than has been generally believed. Similarly in the *sal* forests of Raipur, sambhar and bison are a serious menace to *sal* in regeneration.

PUNJAB.

Considerable damage was done to the seedlings of coniferous species in the nursery by cut worms and cock-chafer grubs. Some damage was done by crickets and possibly also by lizards.

The incidence of attack by *Naiacoccus serpentinus* on the fruit of *Tamarix articulata* was widespread in the plains.

UNITED PROVINCES.

The Forest Entomologist toured in the Landsdowne division to study insect pests of the bamboo. Three types of borers were found on living bamboos. They are :—

(i) *Estigmena chinensis.*—This is the Chrysomelid reported on last year. Although this borer does not kill the shoots, the tunnels reduce their market value very considerably. The damage is widespread and makes it difficult for grades like *sarenchas* and *khaprels* from our forests to compete with such bamboos from dry areas where this damage is rare.

(ii) *Cyrtotrachelus* sp. (*Curculionidae*).—Although large numbers of affected culms were examined, no specimens could be found beyond remains of the head capsules of the larvae near the

dead tops. One of these head capsules was identified at Dehra Dun as *Cyrtotrachelus* probably *longipes* F., a large weevil. The damage done is quite serious extending in some clumps to almost all the new shoots.

(iii) *Myocalandra exarata* (*Curculionidae*).—These borers lay eggs in the abandoned tunnels of *Estigmena chinensis* and the larval galleries run longitudinally in the internodal wall and are not longer than an internode. Damage by this borer is not common and the attack is really secondary.

CHAPTER V.—UTILIZATION AND ECONOMIC RESEARCH.

ASSAM.

I.—General Work of Administration.

Preparations for bringing all remaining forests under either Plans or Schemes being well forward, the question of appointing a Utilization Officer is being raised again, and it will probably be found to be well worth while for Assam to employ one now that the markedly increasing demand for forest produce of all sorts seems to point to approaching prosperity.

II.—Experimental and Commercial Activities.

1. *Wood Technology.*

The examination of 36 specimens of *bonsum* (*Phoebe*) submitted by the Botanical Officer was undertaken by the Wood Technologist at Dehra Dun during the year. The investigation is not yet complete.

Samples of teak (*Tectona*) timber grown in Nowgong were sent to Dehra Dun for test as they were found to be extremely difficult to saw. The following report which is of interest was received as the result of the test :—

> "The material is fast grown and the specific gravity high. In hardness it is 25 per cent. to 50 per cent. more than the Burma and Malabar teak.
>
> After giving the samples which you sent us exhaustive tests in our machines we found that Nowgong grown teak is difficult to work and rapidly turns up the cutting edges of both plane knives and saws.
>
> All three pieces show gummy deposits in their rays and fibres, which may account for the difficulties encountered during sawing."

2. *Timber Testing.*

For vibratory screens as used in the oil wells at Digboi the Assam Oil Company is trying out *ping* (*Cynometra polyandra*). It was found however that the timber supplied to the Company by a contractor, though standing up to the work better than imported hickory, was neither properly seasoned nor correctly sawn and after referring to the Timber Testing Officer, Dehra Dun, the Divisional Forest Officer, Lakhimpur, was able to give the Company further advice on the matter.

As this timber has so far had no commercial value in Assam the matter is of some importance as leading to possible future developments.

3. *Wood Preservation.*

In the absence of suitable local woods, the same Company has been importing red cedarwood from America at a cost of approximately Rs. 5-8 per c. ft. for the construction of cooling towers. It was hoped to try out for this purpose *hollong* (*Dipterocarpus macrocarpus*) treated at the Assam Bengal Railway plant at Naharkatiya but unfortunately owing to the restrictions of the Railway Board regarding the treating of timber for other than very limited railway purposes, this is at present impossible.

The data obtained from the annual durability reports of treated softwood sleepers laid down at Mariani on the Assam Bengal Railway from 1925 were summarized and graphs prepared to estimate the average life. The results have been the subject of special correspondence with the Chief Engineer and it appears that of the treated soft wood sleepers at least *hollong*, *hollock* (*Terminalia myriocarpa*), *jutili* (*Altingia excelsa*), and *sam* (*Artocarpus chaplasha*) show promise of long life comparable with or superior to that of *sal* (*Shorea robusta*).

4. *Paper Pulp.*

The extraction of *muli* (*Melocanna bambusoides*) bamboo in Cachar by the India Paper Pulp Company was continued, some 8 lakhs of bamboos were removed during the year.

5. *Wood Working.*

There has been some demand for *champa* (*Michelia champaca*) for furniture for which purpose it is eminently suitable when properly seasoned.

6. *Miscellaneous.*

Mezankori (*Litsaea citrata*), see last year's report under this head. Plants are now 12′ high and no further damage by deer has been reported. The object of the experiment was for the assistance of silk production and the Agricultural department have been informed of the present results.

Tung oil (*Aleurites fordii*), reference last year's report. 2 plants died during the year, the present average height is 8′. 3 plants seeded during the year.

The following are the results of the analysis of 2 ounces of *Cinchona* bark from the Mikir Hills plantation which were sent to the Quinologist, Mungpoo, Bengal, during the year :—

Sample I.—(Cinchona ledgeriana, Wed.)

	Root.	Stem.	Branch.
Quinine Alkaloid . . .	4·4 per cent. (5·5 Q. Sulph. (B. P.).	3·62 per cent. (4·9 Q. Sul. B. P.).	3·34 per cent. (4·5 Q. Sul. B. P.).
Cinchonidine Alkaloid . . .	·402	·153	·146
Cinchonine Alkaloid . . .	·558	·286	·304
Quinidine Alkaloid . . .	·748	·353	·354
Amorphous	1·134	1·59	1·47
	6·88	6·0	5·62

Sample II.—(Cinchona ledgeriana, Wed.)

Quinine Alkaloid .	per cent.	2·26	2·53	1·71
Cinchonidine Alkaloid	„	·3	·31	·15
Total Alkaloid .	„	4·32	4·6	3·48

The Quinologist, Bengal, remarks "The results indicate that the alkaloid contents are fairly average for C. *ledgeriana* under conditions similar to the Bengal area, while they are slightly better than the corresponding development of the hybrid (*C. ledgeriana C. succirubra*). The quinidine contents appear to be a little high in proportion to other alkaloids. For all practical purposes the plants appear to be *C. ledgeriana*."

It is difficult to judge success or failure from selected samples, for variations between individual plants are rather large in *Cinchona*, while the element of personal bias may lead to large errors of sampling. The analytical results must therefore be studied in relation to the condition of sampling.

The bark sent to the Quinologist was from the following sources :—

(1) Trees already showing signs of deterioration or loss of vigour.

(2) Trees uprooted by winds.

(3) Trees damaged by elephants, etc.

It will therefore be evident that sampling of bark was not made with any special selectivity.

Gurjan (*Dipterocarpus turbinatus*) from Cachar has been successfully marketed in Calcutta for the first time, as also has *jinari* (*Podocarpus*

neriifolia) in the form of shovel handles manufactured by the Bhanga Saw Mills (Cachar).

BIHAR AND ORISSA.

During the latter half of the year considerable attention was paid to improving markets and sales. In this work the Forest Research Officer works in close contact with the Conservator of Forests, Bihar and Orissa. Activities began by reopening correspondence with firms known to be interested in timber supplies, and then by searching for other firms not previously known and by making enquiries abroad, especially in Egypt. Mr. R. L. Derry, I.F.S., while on leave in 1933 in England, also made preliminary enquiries concerning overseas markets and these are being pursued.

The general lines of policy are as follows:

1. Investigation into markets abroad, *e.g.*, Egypt, South Africa, Kenya, Rhodesia, and also in Europe for decorative timber supplies.
2. A survey of the movements of timber in Indian markets which involves an examination of the main consuming centres and sources of timber supplies in Bihar and Orissa and Bengal.
3. Investigation of the means of improving contact between forest contractors and consumers, as well as improving conditions of work for forest contractors in the forests.
4. Efforts to introduce hitherto comparatively useless species on to the market.

Definite results come slowly. But it is interesting to record that a slate manufacturing company of Calcutta has shown definite interest in the mixed species of the Singhbhum forests, so that a reopening of the miscellaneous working Circle there was under consideration at the close of the year. A large market for *semul* (*Bombax malabaricum*) is assured if arrangements for the cheap exploitation of this sporadically occurring tree (the timber of which has now been proved to be equal in quality to that from Assam) can be made.

A number of timber samples were sent to firms for test. Among these may be mentioned *kadam* (*Anthocephalus cadamba*) *tilai*, (*Sterculia urens*), *salai* (*Boswellia serrata*), *gamhar* (*Gmelina arborea*) and *jhingan* (*Lannea grandis*) for slate frames, and *dhaura* (*Anogeissus latifolia*) for tool handles.

Efforts have been made to improve extraction methods. The Forest Research Officer made enquiries into the possibility of using pneumatic tyred wheels running in ball bearing hubs for extraction of fuel from the Puri *Casuarina* plantation over sand. There is some hopes of suc-

cess and the Divisional Forest Officer, Puri, is continuing the investigation and will probably arrange demonstrations. The use of rubber wheeled carts for ordinary forest work is also under consideration.

The Divisional Forest Officer, Palamau, in company with the Indian Paper Pulp Company is investigating the possibility of floating bamboos from the Baresand block and a working experiment will be made in 1934-35. Touch is being kept with this company with a view to extending their bamboo work to other divisions.

The installation of an open tank preservation plant for creosoting *sal* poles and other timbers is under consideration. This may be of great value if the Indian Telegraph Department decide to use treated poles for telegraph posts.

BURMA.

I.—General Work of Administration.

The post of Forest Economist was held by Mr. F. Allsop, Deputy Conservator of Forests, from 1st April 1933 to 14th July 1933, and by Mr. C. W. Scott, Deputy Conservator of Forests, for the rest of the year.

II.—Experimental Activities.

(1) *Wood Technology.*

Requests for identification of timber were complied with, by hand lens examination at Rangoon or by microscopic examination at the Forest Research Institute, Dehra Dun, to whom acknowledgments are due for the help given.

An important study of the variation of teak quality with rate of growth, specific gravity, etc., was initiated in co-operation with Dehra Dun. The matter arose in connection with very slow grown, defective teak found in a broken sole bar (beam) of a Burma Railways goods wagon and with reports by a teak lessee of a certain type of teak of "spongy" and inferior grain, sometimes encountered, more especially in small logs.

The slow grown teak from the broken sole bar was tested and found to be weak and brittle as expected from hand lens and even naked eye examination of the wood. The thin-walled large pores of each annual ring, normally separated from those of the next ring by a belt of thick-walled small pores, were so telescoped and crowded as to be practically continuous. In contrast with a normal average of about 12 rings per inch, this teak showed from 22 to 80 rings per inch and a strength under impact test (for brittleness) 43 per cent. below normal.

Some of this lack of strength was probably due to prolonged over-stressing by heavy loads applied through unsuitable metal fittings, resulting in cumulative fatigue ; but it is certain that even when new this very slow grown, narrow ringed, porous teak was much below normal strength.

One of the teak lessees kindly supplied 91 specimens of teak (6″ × 1″ × 1″) which were sent to Dehra Dun and subjected there to impact tests (for brittleness), with the results tabulated below :—

Description of teak.	Annual rings per inch.	Strength (foot-lbs.).	Specific gravity oven dry.	Per cent. below normal strength.
Normal . . .	15	5·58	·587	..
Wide ringed but not light in weight .	3	4·53	·655	19
Wide ringed and light in weight . .	4	3·70	·496	34

The inference is that for exacting work one should use teak of normal weight and an average of about 4 to 25 annual rings per inch (measured at right angles to the rings), avoiding wood with very crowded rings and light wood even if the rings are not crowded. For very many uses it is unnecessary to trouble about such refinements.

A start was made with the study of the grain variations typical of teak wood from various localities. It appears probable that teak from the drier districts of Burma shows certain characteristic features.

(2) *Timber Seasoning.*

The outstanding feature of the year in the Seasoning Section of the Timber Research Division was the completion of the conversion of the three old Tiemann water spray kilns without fans to internal fan kilns with reversible circulation. This accelerated and cheapened the kiln seasoning greatly, bringing the process much nearer to commercial application in Burma.

For the five internal fan kilns in operation (three of 6 tons capacity, one of 1½ tons and one of 5 cubic feet), the staff was reduced by the conversion mentioned above from 25 to 8 men and the staff cost was almost halved.

The saving of time on runs in the fan kilns, as compared with the Tiemann kilns, was roughly 50 per cent. for soft light box woods like *mau* (*Anthocephalus*), 38 per cent. for the easier cabinet woods such as *ynma* (*Chukrasia*) and 31 per cent. for the more difficult cabinet woods such as *taukkyan* (*Terminalia*).

There was a reduction of fuel costs by some 78 per cent. and of total operating costs by some Rs. 14,000, approximately equal to the capital outlay on converting the 3 large kilns to the internal fan type.

The cost of kiln seasoning fell from Rs. 2-9-10 per c.ft., in 1931-32 to Rs. 1-13-5 per c.ft., in 1933-34, on the 170 tons of timber handled. The cost would have been below one rupee per c.ft., had it not been for loss of time whilst the kiln conversion was being completed and for the unusual proportion of thick wood (*yon* planks) urgently required and taking more time than thinner wood. The 1932-33 cost is not comparable because in that year the kilns were out of action for some months for conversion.

A greater average thickness of timber accounted for the runs being fewer than in the previous year but only 7 per cent. of the full possible kiln time was unused. The timber degrade was less in the new kilns than in the old in spite of the increased speed.

The following 7 species were seasoned in the large 6 ton kilns; *yon* (*Anogeissus acuminata*), *hnaw* (*Adina cordifolia*), *binga* (*Mitragyna diversifolia*), *yinma* (*Chukrasia tabularis*), *sit* (*Albizzia procera*), *kyana* (*Carapa moluccensis*), *taukkyan* (*Terminalia tomentosa*). *Yindaik* (*Dalbergia cultrata*) was seasoned in the 1½ ton kiln and *thitkado* (*Cedrela toona*) experimentally in the 5 c.ft. kiln.

Yinma (*Chukrasia*) boards were brought down 40 per cent. in moisture content in 16 days in the new kilns as opposed to 26 in the old. *Yon* (*Anogeissus*) planks, 2½" thick, for handles, was found to be not unduly slow in seasoning but liable to checking and warping if hurried too much. The 5 c.ft. model kiln gave useful information on this point, showing slight checks on a 38 day schedule, numerous fine checks and warping on a 33 day schedule and bad checks and warping on a 28 day schedule. Of some 93 pieces of furniture made of *taukkyan* (*Terminalia tomentosa*) in the Timber Research Division workshops during the year, only 8 gave trouble by cracking. In some cases this was due to faulty design rather than to seasoning; also some of the wood used was from stock seasoned before the introduction of repeated steamings during the kiln run which have improved results greatly.

Reconditioning of "collapsed" *thitkado* (*Cedrela toona*) boards was successfully carried out in the 5 c.ft. kiln by steaming for 16 hours at 190°—200°F. In the case of *sit* (*Albizzia procera*) it was found that "collapse" could be avoided by keeping the kiln temperature below 130°F. until the wood reached 30 per cent. moisture content, *i.e.*, fibre saturation point.

A comprehensive note on the new kiln equipment, with a diagrammatic plan, was prepared by the Seasoning Officer, Mr. H. Barber, and supplied by request to the Superintendent, Gun Carriage Factory,

Jubbulpore, the Timber Advisory Officer, Railway Board, Delhi, and the Forest Economist, Dehra Dun. In acknowledging receipt, the first named officer mentioned the great development of kiln seasoning at Jubbulpore and the satisfactory results obtained, making it possible to reduce the timber stocks carried and to continue manufacture throughout the monsoon when air drying slows down almost to a standstill.

The reduction of timber stocks under the current policy of strict economy and minimum expenditure curtailed experiments on air seasoning. A study of the ventilation in the air seasoning sheds was concluded, providing useful data on diurnal variation in temperature and humidity. The results were being worked up at the close of the year.

The air seasoning of teak, *pyinkado* (*Xylia*) and *in-kanyin* (*Dipterocarpus*), in the sizes commonly used in Burma or exported, is an important practical question about which information is still inadequate. The exceptionally small shrinkage of teak and the fact that it is girdled and therefore comes to the market at least half dry, allow it to be used successfully for many purposes with no special provision for seasoning, although seasoning is essential to success in exacting work. *Pyinkado* and *in-kanyin*, however, are not girdled and show much greater shrinkage in drying. If used without seasoning they are very liable to move and crack badly. The loss of real value and potential markets due to use and export unseasoned must be great. The increased hardness and difficulty in working of the seasoned wood, especially *pyinkado*, is a factor which must be taken into account but should not prevent seasoning.

(3) *Timber Strength Testing.*

Sample logs of the following 3 species were sent to Dehra Dun for routine Project I tests on small clear specimens :—

Yindaik (*Dalbergia cultrata*).

Thinwin (*Millettia pendula*).

Mau-lettan-she (*Anthocephalus cadamba*).

Logs of *taukkyan* (*Terminalia tomentosa*) were also sent to Dehra Dun with the above for Project VIII veneer tests, and for these same tests arrangements were made for the supply of teak, Lower Burma *kanyin* (*Dipterocarpus alatus*), Upper Burma *kanyin* (*D. turbinatus*) and *in* or *eng* (*D. tuberculatus*), all of which were sent soon after the close of the year.

Two logs of ordinary girdled teak, ex-depot, Rangoon, and two logs of green teak from Pyinmana were sent to Dehra Dun for special shrinkage tests.

Samples of *thitmin* (*Podocarpus wallichianus*) from Tavoy were sent to Dehra Dun for impact tests (for brittleness) to determine its possi-

bilities for aeroplane construction. The results received after the close of the year showed values of only 3½ foot-lbs. against a stipulated minimum of 6 lbs., but fungus infection was present and may have caused the weakness. It is clear that if *thitmin* is ever to be suitable for this work it must be dried quickly after felling, to avoid fungus, possibly by quick extraction in dry weather and immediate kiln seasoning. It is hoped to arrange for further tests on wood free of fungus.

Reference has been made above to certain special tests at Dehra Dun of teak showing normal and abnormal weight and annual rings per inch. These tests have been discussed so far as they relate to peculiarities of grain but it remains to describe certain important results, unconnected with grain, bearing on the failure of teak in railway goods wagons due to cumulative fatigue from prolonged overstressing by unsuitable metal fittings.

In November 1933 the Loco. and Carriage Superintendent, Burma Railways, requested co-operation in studying the failure of teak sole bars or beams which was appearing with disquieting frequency in 4 wheel covered goods wagons. The failure was practically always at one place, by progressive cracking near certain metal fittings (axle guards and spring shoes). These connect the teak bars with the wheels, buffers and other parts of the wagon and pass on to the teak the very variable and sometimes very severe stresses of line running and shunting. The connection provided was evidently unsuitable, weakening the teak bars unnecessarily by bolt holes which could have been better spaced, and concentrating the stress too much. Amongst other evidence to this effect was the fact that failures were reduced by one-third where the teak was used with a later type of axle guard connection which spread the load better than an earlier type.

One teak sole bar was tested at Dehra Dun and found to be 29 per cent. below normal in modulus of rupture and 43 per cent. below normal under the Izod impact test. This, however, was the bar of very porous slow grown wood, described above, and it is uncertain how much of its weakness was due to bad grain and how much to overstressing. Arrangements were made for the testing at Dehra Dun of other overstressed teak bars, with normal grain, and the results will be available in due course.

Rougher but adequate tests of 13 new and 60 old sole bars were made by the Burma Railways at their Myitnge workshops, with very interesting results. The old bars were either apparently "sound from service" or the uncracked portions of bars which had failed in service. Moreover the bars were of two types, one of 7″ × 6″ section manufactured from 1901 to 1922 and one of 9″ × 4¾″ section made from 1923 onwards. The 7″×6″ type is the less suitable for vertical loading and

has been longer in use, so that it may be presumed to have suffered more overstressing than the 9″× 4¾″ type. The actual age of each bar, since brought into use, was unknown but all the 7″× 6″ bars were at least 11 years old and all the 9″× 4¾″ bars were younger, neglecting the minor chance of certain individual 7″× 6″ bars having been renewed after the dropping of the type as a whole.

It was found that old 7″×6″ bars had lost 66 per cent. of the modulus of rupture of new bars of the same section, and that old 9″× 4¾″ bars had lost 15 per cent. compared with new bars of their section. The average breaking load for old 9″× 4¾″ bars was from 23 to 39 per cent. less than that for new bars.

The strength of individual bars showed no relation to the number of rings per inch in their wood. Bars with narrow annual rings sometimes stood up to heavier loads than bars with wider rings. Presumably the explanation is that the overstressing factor overshadowed the usual effect of annual ring width on strength. Other things being equal, wide ringed teak is stronger than narrow ringed ; but badly overstressed teak, even with wide rings, is weaker than narrow ringed teak which has not been so badly overstressed.

Mr. L. N. Seaman of the Timber Testing Section, Dehra Dun, pointed out that such loss of strength with age as had been found in these teak sole bars did not occur in timber unless it was overstressed. The evidence of overstressing is clear. The real cause of the failure is therefore overstressing and not deterioration of properly used teak, an important point which it is desirable to emphasize.

Unfortunately the metal fittings of these wagons do not lend themselves to economical alteration in the interests of teak sole bars and the Burma Railways have reluctantly decided to replace all the teak bars by steel in the course of 8 years at a cost of about Rs. 13 lakhs on 4,400 wagons.

It is probable that the teak would not have failed if more consideration had been given to spreading the load on the wooden bars when these wagons were designed. It is easy to be wise after the event, in the light of increased speeds and loads, and more important in the interests of timber to establish the real facts than to blame old designs for failure under new conditions. This particular use is one for which teak is not so well suited as some other woods, such as *padauk* (*Pterocarpus macrocarpus*). Even if steel proves superior to teak for sole bars it does not follow that metal is superior to teak for goods wagon bodies. Wood such as teak, properly seasoned and used, has certain advantages over metal in good fit, water tightness, insulation and ease of repair which deserve every consideration. Initial price, costs of maintenance and life are vital factors to both materials. If the price

of timber is pitched too high, it will suffer as a competing material. If research which has brought metal to its present excellence is neglected in the case of timber, the latter cannot hope to hold as much of the market as it deserves.

(4) *Wood Preservation.*

There is nothing fresh to record under this head. The general slump and the low price of naturally durable woods such as *pyinkado* (*Xylia*) and *thitya-ingyin* (*Shorea-Pentacme*) practically forbade any developments in creosoted or otherwise preserved wood. It is possible, however, that eventually such plentiful and relatively cheap species as *in-kanyin* (*Dipterocarpus*) and *taung-thayet* (*Swintonia*) will find fresh markets through creosoting, either in Burma or by export, more especially as they are typically large clean sound trees.

(5) *Minor Forest Produce.*

Apart from bamboos for domestic use, the chief minor forest products of Burma are lac and cutch, the former being exported for gramaphone records, electrical insulation, varnishes, etc., and the latter for preserving marine cordage and fishing nets. The volume of lac export quadrupled during the year. It is a trade subject to great fluctuations, especially in Burma where the supplies are mainly from the Shan States and are large when prices are attractive and small when prices fall.

There was further correspondence on the relative merits of Burma cutch containing catechin and Borneo mangrove cutch containing no catechin, for treating fishing nets. The tests by the Imperial Institute, London, suggest that catechin is not the reason for the high reputation of Burma cutch amongst net manufacturers and fishermen but do not prove that the reputation is undeserved.

In November 1933 a Burma sample of 1¼ lbs. of nuts (hulled fruits) of the chief *tung* oil tree, *Aleurites fordii*, was sent to the Imperial Institute, London, through the Economic Botanist, Kew, for examination by Dr. L. A. Jordan, Director of the Research Association of British Paint, Colour and Varnish Manufacturers, who is a member of the Imperial Institute Sub-Committee on *tung* oil. The sample was from immature 3 year old trees in the Forest Department experimental plantation at Taunggyi. This valuable species, *A. fordii*, is not native to Burma although the other valuable species, *A. montana*, is native, being found in Kengtung; and the relatively useless species, *A. triloba* or *moluccana*, which does not produce quick drying oil, also occurs wild or as an escape.

In December 1933 a 2 lb. sample of the nuts of wild *A. montana* from Kengtung was also sent for examination by Dr. Jordan, through

the same channels. The results of both examinations were received after the close of the year under report and showed a normal yield of valuable oil of satisfactory quality, with one peculiarity, that the oil characteristics of the immature *A. fordii* sample from Taunggyi were more like those of *A. montana* than *A. fordii*. The botanical identification of the plants was checked and appeared correct.

Commercial planting of *tung* oil trees is proceeding on a considerable scale at Hsumhsai, Northern Shan States, and it should be possible soon to estimate the prospects for Burma in this product.

The usual number of miscellaneous enquiries for various minor products was received and answered. The costs of collection and transport are often higher in Burma than in India and prevent competition in certain products common to both. Experiments on distilling a tar for wood preserving from the common Shan States pine (*Pinus khasya*) stopped for lack of a suitable retort.

(6) *Paper Pulp.*

The general slump appears to stand in the way of bamboo pulp developments in Burma, but operations in India continue and were watched with interest. Fresh enquiries on the possibilities in Burma were received and answered during the year. Useful data on the rate of recovery from cutting are being got from bamboo sample plots, particularly in Tavoy and Mergui. The general conclusions stated in last year's annual report are confirmed and point towards a choice between clear felling of all culms on a longer rotation or felling of about half of each clump on a shorter rotation, to avoid deterioration in successive crops.

(7) *Tans.*

The only tanning material worked to any considerable extent in Burma (excluding cutch) is the mangrove bark (*Rhizophora* spp.) brought from Tavoy and Mergui for use by the Rangoon tanneries. An enquiry on *myrabolans* was received and answered, the conclusion being that no appreciable export was likely from Burma, chiefly owing to higher costs of collection and freight than in India.

(8) *Wood Working.*

The policy followed in the Timber Research division workshops at Ahlone, Rangoon, was influenced by the slump and the need for drastic economy in all Government expenditure. Every effort was made to reduce both gross expenditure and nett cost (expenditure minus receipts from sales of output) as much as possible. Unfortunately the smaller the output and sales, the heavier the burden of certain fixed

charges for staff and equipment which remain constant, whatever the output, within limits.

A proper balance between pure research on the one hand and commercial demonstration and market development on the other is not easy to maintain, especially in face of a severe slump and economy campaign. In this connection attention is invited to the conclusions of a departmental committee on similar Government activities in South Africa, published in the annual report for 1932-33 of the Forest Department of South Africa. Also to the remarks on general policy by the Divisional Forest Officer, Timber Research Division, Burma, in his Annual Report for 1933-34, Chapter IV, *Research*, 1. General Work of Administration, (3) General remarks.

It appears that research with practical possibilities is the first consideration but that commercial demonstration and market development by Government sales is necessary and right within limits. These limits should be such as to avoid interference with research from trading or revenue considerations and to avoid competition with private enterprise in articles and timbers which are available in adequate quality and quantity from private sources. Subject to the foregoing it seems very desirable to try the results of research by the acid test of public sales and opinion and to seek such revenue as can be got legitimately to lighten the cost of the research staff and equipment.

The general policy of the Timber Research Division is discussed from another angle in sub head (9) on page 112 under "Efforts to increase the sale of Burma timbers". Reference is invited to that discussion for certain broad outlines and to the annual report of the Divisional Forest Officer, Timber Research Division, for 1933-34 for details.

The chief pure research work was in connection with sample batches of plantation teak logs from 6 different divisions. These were cut into 1" boards, those of each log being kept together and serially numbered in their natural sequence for beehole analysis. The results are described in a later section.

An experiment was begun on the workability of teak at various moisture contents and it was arranged to increase the attention to that species of primary importance.

The chief other activities of the year were in finished handles of a common timber, *yon* (*Anogeissus acuminata*), an excellent substitute for ash, and in seasoned and finished boards of *kyana* (*Carapa moluccensis*), a mahogany of the Tenasserim tidal forests. The latter is easy to work, of attractive appearance and used for gramophone cabinets. Both these markets developed satisfactorily and showed promise of appreciable value.

The making of boxes on a major scale for the Burma Oil Co., which bulked large in the operations of 1932-33 was stopped on a question of general policy. The chief wood used for these boxes was *mau-lettan-she* (*Anthocephalus cadamba*), a floating timber available cheap and in considerable quantity. The balance in hand was used for minor orders for boxes from other firms. The place of *mau* in the B. O. C. market was taken by Japanese wood, the time being unpropitious for private enterprise to take up *mau* and the B. O. C. themselves being averse to engaging in industries quite outside their own.

Some 8 industrial or constructional woods and 7 furniture woods received major attention, the species being as follows, approximately in descending order of importance :—

Industrial or Constructional.

1. *Yon* (*Anogeissus acuminata*) for handles.
2. *Mau-lettan-she* (*Anthocephalus cadamba*) for boxes.
3. *Hnaw* (*Adina cordifolia*) for photo printing blocks, etc.
4. *Panga* (*Terminalia chebula*) for oil well sucker rod protectors.
5. *Yemane* (*Gmelina arborea*) for various purposes.
6. *Thitmin* (*Podocarpus wallichianus*) for boat hooks, etc.
7. *Thingan* (*Hopea odorata*) for various purposes.
8. *Binga* (*Mitragyna diversifolia*) for photo printing blocks, etc.

Furniture.

9. *Kyana* (*Carapa moluccensis*)
10. *Yinma* (*Chukrasia tabularis*)
11. *Taukkyan* (*Terminalia tomentosa*)
12. *Padauk* (*Pterocarpus macrocarpus*)
13. *Thitkado* (*Cedrela toona*)
14. *Sit* (*Albizzia procera*)
15. *Thinwin* (*Millettia pendula*)

for furniture, panelling and cabinet work.

Major orders were executed for the East Indian Railway (handles), Gramophone Co., Calcutta (cabinets), Irrawaddy Flotilla Co. (furniture), Judson College (furniture), Indo-Burma Petroleum Co. (sucker rod protectors), Messrs. Arthur Flavell & Co. (half wrought timber) and smaller orders for a wide range of other firms and individual customers.

(9) *Miscellaneous.*

Efforts to increase the sale of Burma timber.

Over 100 different species other than teak have been tested by the division in the last 12 years and the real possibilities narrowed down

to some 20 species. The chief successes have been *yon* (*Anogeissus*) for handles, *mau* (*Anthocephalus*) for boxes, *kyana* (*Carapa*) for gramophone cabinets and *taukkyan* (*Terminalia*) (laurel) and *yinma* (*Chukrasia*) for furniture and panelling. In all these cases new markets have been found, markets for which teak is physically ineligible, being too inelastic for handles, too heavy for boxes, and less attractive for cabinets, high grade furniture and panelling than the woods used.

Little or no attention has been paid to *pyinkado* and *in-kanyin* because it was thought that they needed none, being well known and established woods. Actually it is now clear that research into the proper seasoning and use of these two major timbers is of more importance and promise than much that has been done on minor species.

Future policy and possibilities.

(1) *Teak.*

The lines on which useful work on teak can be done in the Timber Research Division are :—

i. Air and kiln seasoning experiments. The correct schedule for kiln seasoning teak is still unknown and kiln seasoning of all timbers is increasing rapidly all over the world. It dates back only to the war of 1914-18 and is almost certain to be applied to teak in due course though relatively late because teak is girdled and has a low shrinkage. Apart from kiln seasoning, the proper time to air dry teak before use in various climates is still unknown or at best arrived at wastefully by guess work.

ii. Experiments on the optimum moisture content for machine and hand working. A common complaint from Europe and Africa is that teak is hard to work and blunts tools. Much depends on the moisture content or degree of dryness of the wood. Experiments on this subject have been suggested by Sir Hugh Watson and are in hand in co-operation with Messrs. The Bombay Burma Trading Corporation, Ltd.

iii. Experiments on various methods of finishing teak cheaply with a satisfactory appearance. These are better done in Burma where the wood is abundant and relatively cheap than in countries where it is expensive.

iv. Working tests on teak from various localities and from logs of various sizes, more especially to diagnose "spongy" or otherwise defective wood and divert it from keenly competitive to less exacting markets.

(2) *All other woods.*

The period of negative results is over and attention should be concentrated on the 20 or less species of proved value or special promise, with much greater emphasis than in the past on *pyinkado* and *in-kanyin*.

Seasoning kilns are essential to provide seasoned wood for workshop research and demonstration as well as for direct research into seasoning. The cost of kiln seasoning boards is now under one rupee per cubic foot at Ahlone and there are definite hopes of commercial application which seemed remote when the cost was much higher, as it was with the old kilns without the present fans which speed up drying.

Seasoned wood is essential for the new markets referred to above, whether it be obtained slowly by air drying or quickly by kiln drying. At present properly seasoned *pyinkado* and *in-kanyin* are unobtainable in Burma and the waste from haphazard use, green or semi-seasoned, is very great, not to mention the loss of repute and markets abroad through the cracking and warping of wood exported green. If the Timber Research Division can demonstrate how to season *pyinkado* and *in-kanyin* cheaply to a moisture content which will leave the woods sufficiently easy to work and yet reduce cracking and warping, the effects on the export market should be substantial.

To be effective, demonstration must often be on a large scale and for a considerable period. Experienced users of wood are conservative and slow to believe in new species and methods, *e.g.*, it has taken 8 years to achieve the export of Burma *yon* handles on a substantial scale. It will take possibly another 3 to 5 years to establish the reputation of these handles firmly.

Efforts were made to bring the special merits of teak before likely buyers by supplying data for a timber trade lecture in Britain, a lecture subsequently published in the "*Timber Trades Journal.*" Also by an article on teak which was published in the Quarterly Technical Bulletin of the Indian Railway Board for April 1934.

An enquiry for teak telegraph poles was followed up by quotations and correspondence which led to a small trial order in Burma.

An order for 1,100 special size *pyinkado* (*Xylia*) sleepers was handled on behalf of the North Western Railway, Karachi, the order being in the nature of a test of this wood against alternatives. An account of the passing of these sleepers is given below.

The successful use of some 500 tons of long squares of *kanyin* (*Dipterocarpus*), supplied departmentally from Katha division, in erecting the steel bridge across the Irrawaddy near Mandalay (1930-33) was written up, with photographs, and submitted shortly after the close of the year to the Indian Railway Board for publication in the *Quarterly Technical*

Bulletin. The alternative timber for this use was imported Oregon pine (Douglas fir) and there are hopes of increasing the market for the Burma wood in India.

There was considerable correspondence with the Timber Adviser to the High Commissioner for India, London, on existing and possible new markets for Burma woods. The general trade depression and shortage of funds, even for trial shipments, made matters specially difficult. Samples of *yon* (*Anogeissus*) handles were supplied to the Southern Railway (London) who expressed satisfaction with them but found the price unattractive. The possibilities of exporting *taukkyan* (laurel) to London as air dry plank or as logs, preferably figured, were discussed, with special reference to avoiding cracking in transit, but were not tested. The fact that Siam sells in London, as *mai-yang*, a timber apparently identical with Burma *in* or *eng* (*Dipterocarpus tuberculatus*) suggests that export of the Burma wood should be possible, especially with the help of the preferential tariff now in force for Empire timbers. Discussion of this possibility and the specification involved was in progress at the end of the year. The only actual shipment of unwrought timber arranged was 40 tons of *toon* or *thitkado* (*Cedrela toona*) logs which were supplied after the close of the year.

The usual display of Burma timbers was contributed to the Arts, Crafts and Industrial Exhibition held at Rangoon in February 1934 and a descriptive article was supplied for the Exhibition handbook.

A scheme was suggested for regulating the supply of Burma matchwoods by the factory demand, improving the supply and increasing the revenue obtainable. It involved negotiations with the Andamans Forest Department as the chief source of imported matchwood and with the two principal match making companies in Burma. Also an investigation of the actual cost of railway freight per cubic ton on green matchwood logs and collection of data on the average extraction costs from the chief forest areas. The outline of the scheme was accepted by the Conservator's conference of September 1933 and collection of the necessary data was in progress at the end of the year.

The question of standard grading for teak and other timbers came to the fore during the year. It is a suitable subject for this sub-section because it is intimately connected with efforts to increase the sale of Empire woods. The question was raised independently in England and India. In England by a grading sub-committee of the Imperial Institute Advisory Committee on Timbers which published draft rules in October 1933. This sub-committee was specially interested in the less familiar Empire woods and anxious to avoid friction with existing grading systems. Thus for Canadian and New Zealand hardwoods they accepted *en bloc* the "Rules of the National Hardwood Lumber Association," of

American origin ; and they made no mention of teak because they considered the existing grading systems of the five chief teak firms of Burma were adequate.

Each of these firms has a system of its own, with proprietary marks associated with about 8 grades of squares, the chief form in which teak is exported. There are thus five series of grades and about 40 distinguishing marks in use. The grades are not defined in writing, in terms of definite physical defects or limits, and there is no strict system of correlation between the grades used by different firms, although they correspond approximately. A buyer is therefore in some difficulty when choosing between rival quotations of teak or comparing an undefined grade of teak with defined grades of other woods and substitutes.

It was this point, the difficulty of calling for competitive tenders and deciding between alternative offers of undefined grades, that led to the raising of the question of standard grading in India, independently of the Imperial Institute, by the Indian Railways who are one of the chief buyers of teak.

The five leading teak firms are naturally reluctant to change their present grading systems which have served well in the past and embody long experience, good judgment of value and high standards of integrity. They claim that on the average their grades do not vary and can be relied on implicitly, irrespective of the state of the market. They emphasise the difficulty of defining the present grades on paper, the need for elasticity in any system of definitions and the extent to which grading experience is essential, apart from what can be defined. They point out also that for satisfactory use in a busy mill a system should be such as can be quickly and economically applied, without over-elaborate enumeration and measurement of minor defects and blemishes.

These arguments and the established reputation of the old grades and marks deserve every consideration So also does the fact of increased competition with teak by other timbers and substitutes for wood. It is common ground between the teak firms and the advocates of standard grading that nothing possible should be neglected in the effort to strengthen teak against competitors. If the present systems of teak grading can be defined and correlated on any sound practicable basis, it seems certain that such action would benefit the teak trade as a whole.

The possibilities were discussed with the teak firms during the year under report by the Conservator of Forests, Utilization Circle, Burma, and two officers from India, the Timber Advisory Officer to the Railway Board, and the Officer-in-charge of the Timber Testing Section, Forest Research Institute, Dehra Dun, Mr. L. N. Seaman, who has special knowledge of grading timbers other than teak. It was arranged to collect data in the Rangoon and Moulmein teak mills for further discussion and

in the last month of the year three Assistant Conservators of Forests were posted to special duty for this purpose. With the permission and co-operation of the lessees these officers will observe the current grading systems, recording detailed data on lines suggested by Mr. Seaman so that the possibility of definition and correlation of existing grades and marks can be investigated. There is good reason to hope that a sound scheme will be evolved, retaining the merits of the present marks and removing the difficulties of comparison.

(3) *Departmental export of Burma timbers.*

The general trade depression and shortage of funds stopped all departmental export of timber other than the teak supplied as usual to the Admiralty by the Depot and Agency division. Two orders of 20 tons each for logs of *toon* or *thitkado* (*Cedrela toona*) were received from Messrs. Leary & Co., London, through the Timber Adviser to the High Commissioner for India, London. They were supplied after the close of the year, from Katha division. The specification was length 8 to 19 feet and girth 7′ and up.

(4) *Timber Passing.*

The only major passing of the year was on behalf of the North Western Railway, Karachi, who bought 1,100 special size sleepers of *pyinkado* (*Xylia*) through the Utilization Circle, Burma, to test the wood against alternatives. The order was divided between a Moulmein firm who were allowed to supply sleepers with sound boxed heart, without limit, at a slightly lower price, and a Toungoo firm who had to supply at least $\frac{2}{3}$ of their sleepers free of heart, at a slightly higher price per sleeper on their order as a whole. The passing standard of the Burma Railways was studied and an effort was made to strike a suitable standard for Karachi, not impossibly high for futher orders at a competitive price but high enough to demonstrate the excellence of Burma *pyinkado*.

Considerable rejection (18 to 28 per cent) was necessary at first, to set the standard chosen. The chief cause of rejection (60 to 70 per cent) was sapwood which is useless because it rots. It should be treated simply as wane. Unsound heart and serious cracks accounted for most of the other rejections. As far as possible the sleepers were passed finally by the writer at the mill where they were cut. When this was impossible, a preliminary passing by an assistant was arranged at the mill and final passing at Rangoon.

The price paid for the Moulmein sleepers with 100 per cent boxed heart was about 90 per cent of the price of the Toungoo sleepers with only $\frac{1}{3}$ of their number showing boxed heart. It is probable that sleepers clear of heart are worth more than this small amount of price superiority

over boxed heart sleepers because the latter cannot be expected to last nearly as well. The average girth of Moulmein *pyinkado* logs is considerably less than that of Toungoo and most other Pegu Yoma *pyinkado*. It is said to be impossible to cut many sleepers free of heart at Moulmein and the larger the sleeper size the more difficult it is elsewhere. A boxed heart *pyinkado* sleeper is good value at a certain price but it should be suitably lower than that paid for sleepers free of heart; and the larger the sleeper size the lower the percentage of pieces free of heart which can be expected at any reasonable price.

(5) *Wood fuel for the Burma Railways.*

The general question of the best arrangements for supplying wood fuel to the Burma Railways at various consuming points on their system arose in connection with a threatened shortage at Myitnge. The furnaces at the carriage and wagon works there are specially designed for wood fuel but owing to defective arrangements for supply it became necessary to consider coal. The balance of advantage in price, between wood and coal, is delicate and unless forests reasonably near fuel consuming centres are made available, the freight on the wood becomes too high and lets in coal. Domestic and other requirements have to be considered but as far as possible it is desirable to promote the use of wood fuel by the Railways because of the revenue and employment provided. The difficulties at Myitnge were overcome and a general scheme drawn up to facilitate supplies throughout the province in future.

(6) *Enquiries and Liaison.*

Miscellaneous enquiries were answered on timber, fuel, bamboos, lac, *tung* oil, etc. The usual liaison was maintained with other specialists in Burma and at the Forest Research Institute, Dehra Dun; also with the Forest Products Research Laboratory, Princes Risborough, England, the Imperial Institute, London, the Royal Botanic Gardens, Kew, and the Timber Adviser to the High Commissioner for India, London. Acknowledgments are due for help from all these sources.

CENTRAL PROVINCES.

I.—General work of administration.

The post of the Forest Utilization Officer was held by Mr. Abdus Salam throughout the year. He continued to organise the supply of sleepers and to hold the auctions at the timber depots at Khirkia, Timarni, Taku, Ellichpur and Ballarshah. Sales amounting to Rs. 8,38,212 have been made by him, compared with Rs. 7,82,111 in 1932-33. He also gave information and advice to local officers and the public and made efforts to find markets for minor produce.

II.—Experimental and Commercial activities.

(1) *Timber Testing.*

At the request of the Forest Economist, specimens of *padar* (*Stereospermum xylocarpum*) and *saj* (*Terminalia tomentosa*) were sent to the Forest Research Institute. Logs of *garari* (*Cleistanthus collinus*) have also been sent to Dehra Dun for testing, in the hope that this timber will be found suitable for use by the Public Works Department.

(2) *Minor Forest Products.*

Lac.—Climatic conditions were very favourable for lac, and the crop was excellent, especially in Saugor, Bhandara and Damoh. As a result of the rise in prices, departmental propagation has again been undertaken in several divisions.

Harra.—The crop gave excellent early promise, but was partially spoiled by heavy rains and winds. There has been a serious fall in the Calcutta market price during the last two years.

Gum karaya (*Sterculia urens* gum).—The market for this gum continues to develop. It is reported that 59,000 cwts. were exported from Bombay, mainly to Japan, during the year, against 37,741 cwts. in 1932-33. The revenue from this gum rose from Rs. 5,000 in the previous year to Rs. 9,000 in 1933-34.

(3) *Paper Pulp.*

Enquiries were made by various firms regarding the adequacy of the supply of bamboos (*Dendrocalamus strictus*) for paper pulp mills. No definite negotiations, however, have yet been opened.

(4) *Tans.*

The divisional forest officer, Saugor, sent specimens of the fruit of *ghont* (*Zizyphus xylopyra*) to the Bengal Tanning Institution. The analysis was not very favourable.

(5) *Miscellaneous.*

Charcoal.—Charcoal rates improved during the year and heavy exports were made to Bombay from several divisions.

Sal scantlings.—A market for sal scantlings is being gradually developed. There was an increase in the number sawn in the Raipur division, and small orders were also supplied from Mandla and Balaghat.

MADRAS.

I.—General work of Administration.

The Forest Utilization Officer continued to organize sales of logs, sleepers and minor forest produce and was in charge of the disposal of timber in the chief timber producing divisions of Coimbatore South, Nilambur and Wynaad. Technical advice was given, as usual, to the Railways and the public for the preferential use of local timbers.

II.—Experimental and Commercial Activities.

(i) *Timber Testing.*—The supply of the following timbers was arranged for test under the various projects in the Forest Research Institute, Dehra Dun.

Project I.— (i) *Pterocarpus santalinus.*
(ii) *Artocarpus integrifolia.*
(iii) *Eleocarpus tuberculatus.*

Project II.—(i) *Dalbergia latifolia.*
(ii) *Poeciloneuron indicum.*

Note—Test of *Artocarpus interifolia* under Project II had to be dropped for want of logs of sufficient length.

Project VIII.— (i) *Lophopetalum wightianum.*
(ii) *Anogeissus latifolia.*
(iii) *Tetrameles nudiflora.*

Most of these are being despatched now (1934-35).

The results of tests under Project II of Nilambur plantation and Anamalai teak, and of Upper Godavari teak and certain miscellaneous species under Project VIII, received from the Forest Research Institute, Dehra Dun, were communicated to the officers of the Department.

(*ii*) *Durability tests on sleepers.*—A joint inspection with an officer of the South Indian Railway and Madras and Southern Mahratta Railway, of treated and untreated experimental sleepers of *Cullenia excelsa, Eugenia gardneri, Dipterocarpus indicus,* and *Dalbergia latifolia,* was made by the Forest Utilization Officer, and the results were communicated to the Forest Research Institute, Dehra Dun, and Railways.

(*iii*) *Paper Pulp.*—A supply of 20 lbs. of *lantana* from the Central Salem division was made to the Forest Research Institute, Dehra Dun, to test its suitability for paper pulp and the result is awaited.

(*iv*) *Matchwood.*—An experimental supply of *Vateria indica* logs was made from the Wynaad division to the Western India Match Company, Madras. The timber was reported to be not quite suitable

for splints, due to its darkish colour, but before arrangements could be made for adequate supply to test for boxes the firm had to close their factory on account of the new excise duty on matches.

Commercial Activities.

(i) *Sleepers.*—A supply of 21,975 broad gauge and 13,132 meter gauge hardwood sleepers (*Mesua ferrea, Hopea parviflora* and *Xylia xylocarpa*) and also of 4,500 broad gauge, 4,500 meter gauge, and 9,000 narrow gauge, teak sleepers was organized, and the sleepers were passed by the Forest Utilization Officer for the Sleeper Pool, Southern Group in 1933-34.

Besides the supply of 6,482 special sized teak sleepers (30,504 cubic feet) valued at Rs. 1,04,715, a supply of 250 meter gauge special size (6′×8″×6″) hardwood sleepers was made to the South Indian Railway for test length experiments in certain sections of their Railway. The supply of 2 consignments of 800 broad gauge and 700 broad gauge hardwood sleepers was also organised and passed for the Madras Port Trust at Rs. 5-2-6 and Rs. 5-8-0 per sleeper for the respective consignments.

The prices received for broad gauge and meter gauge hardwood sleepers were Rs. 5-2-6 per broad gauge and Rs. 2-5-0 per meter gauge; for teak Rs. 8-0-0 per broad gauge, Rs. 3-0-0 per meter gauge, and Rs. 2-8-0 per narrow gauge. Though the supply of sleepers to the Southern Group of the Sleeper Pool for 1934-35 had to be dropped owing to the very poor competitive rates tendered by private contractors, negotiations are proceeding with a view to obtain a three-year contract with the railways from 1935-36.

(ii) The report received from the Madras and Southern Mahratta Railway on bolted sleepers laid in the line, showed that they were in good condition, though it was too early to state whether they had stood all wear and tear, as they were in the road for only a short time.

(iii) The demand from the railways for indigenous teak showed a tendency to increase, and the Forest Utilization Officer was able to secure contracts for the supply of teak to the South Indian Railway and Madras and Southern Mahratta Railway. About 52 tons at a rate of Rs. 150 per ton f.o.r. Nilambur to the South Indian Railway, 80 tons at Rs. 137-8-0 per ton f.o.r. Madras to the Madras and Southern Mahratta Railway and a further 120 tons at Rs. 144 per ton f.o.r. Jalarpet to the Madras and Southern Mahratta Railway were supplied during 1933-34. The value of the above orders works out to approximately Rs. 37,500.

(iv) After considerable correspondence, Government have issued orders to all Government departments who consume timber, to consult the Forest Utilization Officer regarding their requirements of timber.

We are at present complying with some jail department orders. Previously most of their requirements had been for sawn timber which we could not supply owing to the closing of our saw mills, but this difficulty has been overcome by arranging for the supply of sawn timber through a private contractor who purchased one of our Government saw mills and who now buys timber in the log from us and saws it in his mill. It is hoped that other Government Departments will follow suit in buying the timbers of their own Presidency.

(v) *Special orders and Overseas Trade.*—1,719 cubic feet of *Grewia tiliaefolia* logs were supplied to the Gun Carriage Factory, Jubbulpore, at Rs. 1-4-0 per cubic foot f.o.r. Pollachi.

About 70 cubic feet of *Grewia tiliaefolia* was also supplied to the Buckingham and Carnatic Mill Company, Ltd., Madras, at Rs. 1-8-0 per cubic foot f.o.r. Pollachi. 1,872 cubic feet of laurel logs were supplied to a firm in London through the Timber Adviser to the High Commissioner for India, London, at 5½ shillings per cubic foot c.i.f. London. There is no more demand for this species for the present.

(vi) *Timber Market.*—The depression in the timber market continued, though there were slight occasional improvements. The demand, as usual, was for teak, rosewood, *irul* (for sleepers), *kindal* (*Terminalia paniculata*) laurel, benteak, *bijasal* (*Pterocarpus marsupium*), *dhaman* (*Grewia tiliaefolia*) and other miscellaneous species for special purposes. The rate for good quality teak and rosewood ranged from Rs. 1-8-0 to Rs. 3-0-0 per cubic foot and for other miscellaneous species from about 8 annas to Rs. 1-4-0 per cubic foot which should be considered a fair rate.

The total value of sales made by the Forest Utilisation officer during the year was Rs. 4,86,821.

Liaison.—The usual liaison with the Forest Research Institute and Timber Adviser to the High Commissioner for India, London, was maintained.

Minor Forest Products.

Nux vomica.—The demand for *Nux vomica* seeds, mainly for export purposes was dull, and about 300 *candies* were sold from the Nellore division at a low rate of Rs. 11-4-0 per *candy* of 500 lbs.

Tans.—Continued cheap imports of South African wattle bark adversely affected the sale of the tan-barks *Cassia auriculata* and *Cassia fistula.*

The examination of *Cassia auriculata* bark of known ages from the experimental plantations in Vizagapatam and Nellore will be due only in 1934-35.

Lac.—Cultivation of lac on a limited scale was continued in the North Salem and Madura divisions. The operation though quite successful was restricted to the minimum due to the depressed state of the lac market. Special endeavours were therefore made to interest the Jail Department in purchasing Madras grain lac for the manufacture of sealing wax supplied by the jails to the Superintendent of Stationery, and 3,166 lbs. of grain lac were supplied to the jails at a rate of Rs. 25 per Bengal maund of 82 lbs.

The Jail Department has also agreed to buy Madras shellac for making superior sealing wax, and arrangements are being made to supply them with it at eight annas a pound.

Two other subsidiary operations connected with lac were also undertaken in the North Salem division, *viz.*, the preparation of sealing wax and wood polish from lac. The wood polish was found to be as good as imported polish, and the Inspector General of Prisons was pleased to issue instructions to all the jails in the Presidency to purchase their requirements from the Madras Forest Department. Orders for wood polish were not received until 1934-35 and are being complied with now.

Attempts were also made to interest local firms, railways, etc., by sending them samples of sealing wax prepared by the Department but without success, mainly due to the very low competitive rates at which they purchase from other sources.

A special quality of sealing wax as used by the Post Office was also made and sent to the Controller of Stores, Calcutta. The matter is still under correspondence.

The marketing of lac has presented difficulties but with the assured co-operation of the jails and other Government departments it is hoped to put it on a systematic basis. Attempts are also being made through the Secretary, Lac Cess Committee, Calcutta, to interest some exporters in the regular purchase of Madras lac.

APPENDIX I.

List of Provincial Forest Publications of 1933-34 (excluding the Forest Research Institute Publications).

ASSAM.

Indian Forester Articles:

Observations on soil æration. R. C. Dutta.

Aided Natural Regeneration of *Hollock*. A. R. Thomas.

BENGAL.

Nursery and plantation notes for Bengal, 1933.

BIHAR AND ORISSA.

Indian Forester: The Forests of Orissa States. H. F. Mooney.

BOMBAY.

Indian Forester:

Early stump planting of Teak in Kanara North Division. M. V. Divekar.

Kandi (*Prosopis spicigera*) forests in Sind. B. B. Wadhwani.

BURMA.

Indian Forester:

Preliminary note on shot-holing of converted teak. D. J. Atkinson.

Calopepla leayana in the *Gmelina arborea* plantations at Nanitu. D. J. Atkinson.

Some Burma Notes on the Problem of Pure Teak Plantations. H. R. Blanford.

Soil deterioration in Pure Teak Plantations. H. E. Castens.

Karen stock-method of capturing wild elephants. J. A. Clarke.

The Cultivation of *Tung* (*Aleurites fordii*) in the Shan States. A. Long.

Durable bamboo lacquer ware in Burma. U. Pe Kin.

A Roller winch used in Burman Villages. U. Kantaya.

CENTRAL PROVINCES.

Indian Forester: Katha Industry in Central Provinces. Tara Singh.

MADRAS.

Indian Forester:

Wireless for the Forest Officer. W. C. Hart.

Control of Lantana. E. K. Krishnan.

Planting up gaps in deciduous forest. A. Minchin.

A large *Strychnos nux-vomica* Tree. M. V. Laurie.

Rab Method in North Cuddapah. S. Raghunatha Rao.

A plea for our softwoods. W. C. Hart.

PUNJAB.

Forest Leaflet No. 9.—Departmental exploitation.

Forest Leaflet No. 10.—Construction and repair of buildings.

Forest Leaflet No. 12.—Storage of explosives and methods of blasting.

Forest Leaflet No. 13.—Resin tapping instructions and rules.

Indian Forester:

Fomes annosus on Deodar. K. L. Aggarwal.
Kulu and Seraj. A. M. David.
The Salarang Exploitation. Jalmeja Singh.
Deodar Sowings in the Dry Zone. Kailash Chandra.
Note on Larch in Kulu. N. G. Pring.
Cultivation of *Farash* (*Tamarix articulata*). P. N. Suri and R. S. Chopra.

UNITED PROVINCES.

Indian Forester:

Taungya plantations in the Saharanpur Forest Division. M. P. Bhola.
Polyporus shorea (Sal root fungus) in Bahraich Division. D. Davis.
Wireless for the Forest Officer. C. M. Hopkins.
Branching of teak in plantations. J. K. Pande.
Calculation of yield for Sal Forests. E. A. Smythies.
Safeguarding formula for selection fellings. E. A. Smythies.
Silvicultural Systems for Sal in United Provinces. E. A. Smythies.
Note on the Forests of Ajmer-Merwara. W. F. Coombs.

APPENDIX II.

Statement showing rank, designation and address of Forest Officers, employed exclusively on research work in the various Provinces during the year 1933-34.

Serial No.	Name.	Designation.	Address.
1	Mr. A. Das, Deputy Conservator of Forests.	Attached to the Direction Division on special duty, Assam.	Shillong.
2	Mr. C. K. Homfray, Deputy Conservator of Forests.	Silviculturist, Bengal .	Darjeeling.
3	Mr. J. N. Sen Gupta, Extra Assistant Conservator of Forests.	Range Officer, Southern Range of the Silvicultural Division, Bengal.	Chittagong.
4	Mr. B. P. Basu, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa (for part of the year).	Ranchi.
5	Mr. F. C. Osmaston, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa (for rest of the year).	Do.
6	Mr. F. Allsop, Deputy Conservator of Forests.	Forest Economist, Burma (for part of the year).	Rangoon.
7	Mr. C. W. Scott, Deputy Conservator of Forests.	Forest Economist, Burma (for rest of the year).	Do.
8	Mr. R. W. V. Palmer, Deputy Conservator of Forests.	Silviculturist, Burma .	Maymyo.
9	Mr. H. S. George, Deputy Conservator of Forests.	Silviculturist, Central Provinces (for part of the year).	Betul.
10	Mr. H. C. Watts, Deputy Conservator of Forests.	Silviculturist, Central Provinces (for rest of the year).	Nagpur.
11	Mr. Parma Nand Suri, Extra Assistant Conservator of Forests.	Divisional Forest Officer, Silvicultural Division, Punjab (for part of the year).	Lahore.
12	Mr. Ishwar Das Mahendru, Extra Assistant Conservator of Forests.	Divisional Forest Officer, Silvicultural Division, Punjab (for rest of the year).	Do.
13	Mr. Ude Singh, Extra Assistant Conservator of Forests.	Assistant to the Divisional Forest Officer, Silvicultural Division, Punjab (from 21st January 1934 to end of the year).	Do.
14	Mr. Ram Saran Chopra, Extra Assistant Conservator of Forests.	Assistant to the Divisional Forest Officer, Silvicultural Division, Punjab.	Do.
15	Mr. E. C. Mobbs, Deputy Conservator of Forests.	Silviculturist, United Provinces.	Naini Tal.
16	Mr. Sohan Singh Negi, Extra Assistant Conservator of Forests.	Assistant Silviculturist, United Provinces.	Do.

APPENDIX III.

PUBLICATIONS OF THE FOREST RESEARCH INSTITUTE, DEHRA DUN, AVAILABLE FOR SALE.

I.—BULLETINS (OLD SERIES).

	Price (exclusive of packing, postage, etc.). Rs. A. P.
*4. *Ficus elastica* : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
*6. Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0

II.—LEAFLETS—(*All out of print.*)

III.—PAMPHLETS.

*6. Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	1 0 0
*8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia	0 10 0
*9. Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author	0 10 0
*10. Note on Burmese Leza Wood (*Lagerstroemia tomentosa*, Presl.), by R. S. Troup	0 2 0
*16. Note on the Best Season for Coppice Fellings of Teak (*Tectona grandis*), by R. S. Hole	0 4 0

IV.—BULLETINS (NEW SERIES).

*3. Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0 4 0
*6. Memorandum on the Oil-Value of Sandalwood, by Puran Singh . .	0 2 0
*7. Note on the Chemistry and Trade Forms of Lac, by the same author .	0 3 0
*8. Note on some Germination Tests with Sal Seed (*Shorea robusta*), by R. S. Troup	0 2 0
*9. Note on Resin-Value of *Podophyllum emodi* and the best season for collecting it, by Puran Singh	0 1 3
*11. A Further Note on some Casuarina Insect Pests of Madras, by V. Subramania Iyer	0 14 0
*13. Note on *Ligno Protector* as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0 5 0
*14. A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0 3 0
*15. Note on the Technical Properties of Timber with special reference to *Cedrela toona* wood while seasoning, by the same author . . .	0 3 0
*16. Note on Gumhar (*Gmelina arborea*, Roxb.), by A. Rodger . . .	0 3 0
*17. Note on Bija Sal or Vengai (*Pterocarpus marsupium*, Roxb.), by the same author	0 4 0
*18. Note on Sain or Saj (*Terminalia tomentosa*, W. and A.), by the same author	0 5 0
*19. Note on Benteak or Nana Word (*Lagerstroemia lanceolata* Wall.), by the same author	0 3 0

IV.—BULLETINS (NEW SERIES)—*contd.*

	Price (exclusive of packing, postage, etc.). Rs. A. P.
*20. Note on Sandan (*Ougeinia dalbergioides*, Benth), by the same author	0 3 0
*21. Note on Dhaura Bakli (*Anogeissus latifolia*, Wall.), by the same author	0 4 0
*22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 0
*23. Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Hole	0 4 0
*24. Note on Turpentines of *Pinus khasya*, *Pinus merkusii* and *Pinus excelsa*, by Puran Singh	0 2 0
*25. Development of the Culms of Grasses, by R. S. Hole	0 2 0
*26. Note on the Resin Industry in Kumaun, by E. A. Smythies	1 4 0
*27. Note on Blackwood (*Dalbergia latifolia*, Roxb.), by E. Benskin	0 4 0
*28. Note on Dhauri (*Lagerstroemia parviflora*, Roxb.), by the same author	0 4 0
*29. Note on Sundri Timber (*Heritiera minor*, Lam.), by R. S. Pearson	0 3 0
*30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
*31. Note on Indian Sumach (*Rhus cotinus*, Linn.), by Puran Singh	0 2 0
*32. Note on the Burma Myrobalans or " Panga fruits " as a Tanning Material, by Puran Singh	0 1 0
*33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
*34. Note on Red Sanders (*Pterocarpus santalinus*, Linn. f.), by T. A. Whitehead	0 9 0
*35. Note on Babul (*Acacia arabica*, Willd.), by J. D. Maitland-Kirwan	0 5 0
*36. Note on Kokan or Lampatia Timber (*Duabanga sonneratioides*, Ham.), by R. S. Pearson	0 3 0
*37. Note on the Contraction and Warping which takes place in *Pinus longifolia* timber while seasoning, by the same author	0 11 0
*38. The Construction of Calcareous Opercula by Longicorn Larvae of the Group *Cerambycini* (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
*39. Note on Hollong Timber (*Dipterocarpus pilosus*, Roxb.), by R. S. Pearson	0 4 0
*40. Note on Pyinma, Ajhar or Jarul Wood (*Lagerstroemia flos-reginae*, Retz.), by the same author	0 6 0
*41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion	0 8 0
*42. Note on Haldu (*Adina cordifolia*, Hook, f.), by C. E. C. Cox	0 8 0
*43. Note on *Odina wodier*, Roxb., by the same author	0 8 0
*44. Note on Semal or Cotton Wood (*Bombax malabaricum*), by the same author	0 10 0
*45. Note on the Miscellaneous Forests of the Kumaun Bhabar, by E. A. Smythies	1 0 0
*46. Rate of Growth of Bengal Sal (*Shorea robusta*), I Quality, by S. H. Howard	1 0 0
*47 Volume Tables and Form Factors for Sal (*Shorea robusta*), by the same author	0 6 0
*48. Note on Kindal (*Terminalia paniculata*), by R. S. Pearson	0 6 0
*49. Note on Thingan (*Hopea odorata*, Roxb.), by A. Rodger	0 7 0
*50. Note on Gurjun or Kanyin (*Dipterocarpus* spp.), compiled by W. A. Robertson	0 4 0
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*56. A Report on the Tan Values of Indian Myrobalans and Burma *Terminalias*, by J. A. Pilgrim	0 6 0
*57. Tan Investigation of the Burma Hill Pine, *Pinus khasya* bark and *Pyinkado*, *Xylia dolabriformis*, by the same author	0 3 0
*58. General Volume Tables for *Chir* (*Pinus longifolia*), by S. H. Howard	0 8 0
*59. Summary of results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India, by J. H. Warr	1 14 0

IV.—BULLETINS (NEW SERIES)—*concld.*

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*62. Preliminary Yield Table for *Dalbergia sissoo*, by S. H. Howard	0 2 0
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V.—FOREST RECORDS.

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* „ Part IV.—Note on Host Plants of the Sandal Tree, by the same author	2 0 0
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* „ Part	VII.	—The Life-History of the Toon Shoot and Fruit Borer, *Hypsipyla robusta*, Moore, with suggestions for its control by C. F. C. Beeson .	2 4 0
*Vol. VIII, Part	I.	—Report on Lac and Shellac, by H. A. F. Lindsay & C. M. Harlow	2 12 0
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*	„ Part	VIII.—The Constituents of some Indian Essential Oils, Parts IX and X, by J. L. Simonsen . .	0 4 6
*	„ Part	IX.—Note on the Work of Extraction of Broad Gauge Sleepers from Nepal, by J. V. Collier . .	1 11 0
*Vol.	X, Part	I.—The Constituents of some Indian Essential Oils, Part XI.—The Essential Oil from the leaves of *Cupressus torulosa*, Don., by J. L. Simonsen	0 3 0
*	„ Part	II.—Oils and Fats from the Seeds of Indian Forest Plants, Part VI. The Oil from the Seeds of *Aleurites montana* Wils., by R. N. Parker, M. Gopal Rau, W. A. Robertson and J. L. Simonsen, and Part VII.—The Oil from the Seeds *salvia plebeia*, R. Br., by M. Gopal Rau and J. L. Simonsen	0 9 0
*	„ Part	III.—A Sal Yield Table for the United Provinces, by E. A. Smythies and S. H. Howard . .	1 5 0
*	„ Part	IV.—The Constituents of some Indian Essential Oils, Part XII.—The Essential Oil from the Oleo-resin of *Pinus merkusii*, by J. L. Simonsen .	0 2 0
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*	„	Part	VI.—Yield and Volume Tables for Deodar, by the same author	0 8 0
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*	„	Part	V.—Epidemic attacks by the Sal Heartwood Borer (*Hoplocerambyx spinicornis*) in the Forests of South Mandla Division, C. P., by W. A. Muir	2 10 0
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FOREST RESEARCH IN INDIA, 1934-35.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

Work was continued in accordance with the sanctioned programme and all urgent problems submitted to the Research Institute were attended to. The Board of Forestry which met in October 1934 considered the necessary co-operation in research between the Provinces and the Forest Research Institute and the advancement of forestry in India.

Silvicultural Branch.—The most important event of the year was the 4th Silvicultural Conference held during the year. This was attended by 35 delegates representing all the Provinces and most of the important Indian States. Important decisions were taken regarding research methods and a large field of silvicultural work was covered.

The investigations on various silvicultural problems were continued in accordance with the triennial programme and satisfactory advance was recorded in several directions.

The severe frost of January 1935 killed many plants down to the ground and vitiated important experiments in the Demonstration Area. The teak experimental plantations have been almost entirely destroyed.

The all-Indian teak seed origin investigation has been taken a step further and is likely to provide valuable data for areas where all seed has to be imported.

Statistical work shows a steady increase and the staff was fully occupied in computing data of sample plot files received from the provinces. The number of permanent sample plots has increased from 1246 in 1930-31 to 1502 in 1934-35.

The year under review records completion of a note on "Forest Types" now in the press.

The photographic section records important additions of prints, lantern slides and cinema films. Slides and films were lent to a few

Divisional Forest Officers and the Forest Research Institute arranged for a public lecture on the utility of forests in Kotdwara illustrated with lantern slides.

The Ceylon Government obtained the services of Mr. H. G. Champion, the Central Silviculturist, for about four months to advise them regarding forest policy.

Botanical Branch.—The systematic study of several important tree species in particular *Dipterocarpaceae* and *Terminalias* was continued. There was a further addition of 3,560 sheets to the herbarium and 1,258 specimens were distributed to various museums in foreign countries on an exchange basis. The card indexing of periodicals and books on botanical subjects was brought up to date. The Botanist spent a good deal of his time in identifying specimens and answering technical enquiries on botanical subjects from forest officers all over India. The determination of the Hydrogen ion value of forest soils with reference to problems of regeneration in the Kulu division of the Punjab received attention. The President has to thank Dr. McKenzie Taylor of the Irrigation Research Institute, Lahore, for his very valuable services in this investigation. His work is being published as a forest record.

In mycology the investigation of the shisham root disease has been closed and a report is being written up. The Mycologist continued his investigations of rust disease on conifers in Chakrata and a large collection of possible alternate hosts was made.

Entomology.—The entomological branch has maintained a high output in the fields of pure entomology, forest protection and the utilisation of timber. Some of the results have appeared in the twenty-three articles published during the year.

The relative importance of insects, fungi and other factors in the dying-off of *Shorea robusta* was investigated with the conclusion that only one insect, *Hoplocerambyx spinicornis*, is capable of killing healthy trees. Measures for the protection of standing sal trees from damage by secondary borers were successfully applied.

Biological work on the borer pests of living trees, such as the *Phassus* borer of teak, eucalyptus and cryptomeria, the *Estigmena* and *Cyrtotrachelus* borers of bamboo, show that effective control can be obtained by modification or correct application of silvicultural measures.

Dr. Beeson's demonstration that the principles of biological control can be applied to teak plantations for protection against defoliators introduces what is probably the solution to all the problems of pest suppression in " pure " plantations. Most of the remedies can be attained by silvicultural operations if these are supplemented by the introduction of parasites and predators.

Borers of logs, of plywood and planking and of timber in salt water, have been investigated and measures have been devised for reduction of the damage caused by them. Mr. Gardner's taxonomic studies of the larval stages of borers have removed many of the difficulties connected with their identification.

Special attention has been paid to a pest of champ plantations, *Urostylis punctigera*, the seasonal history of which has been worked out, and to the economic importance of cutworms and cockchafers in coniferous forests.

About 25,000 insects were bred in the Dehra Dun insectary and 570 new species were added to the Institute collection.

Economic Branch.—The Institute has lost the services of Mr. L. N. Seaman who had initiated all the work done on the testing of Indian Timbers and whose association with the Institute over a long period of years has been very valuable. Before leaving Mr. Seaman was able to complete his proposals for the grading of teak squares. A work which involved the assessment and valuation of defects in 6,000 teak squares, the property of the leading Burma firms. This matter is now under the consideration of the firms concerned and it is hoped that a standard classification throughout the trade will soon be an accomplished fact.

A further meeting of the Raman Committee to consider the treating of timber with " Ascu " was held at Simla in June 1934 and a good deal of correspondence has taken place regarding treated telegraph poles. A large experimental treatment of railway sleepers will be undertaken.

The President convened a meeting of all the pulp and paper interests of India in Calcutta in March 1935 to consider what research should be carried out at Dehra Dun. It is a pleasure to record that this conference was most successful.

Dr. Kapur's experiments on seasoning have considerably reduced the cost of this process in which many people are now becoming interested. One of the most important investigations in hand is the suitability of Indian woods for veneer and considerable progress was made. A certain amount of interest was also shown in the commercial application of our work.

The services of the wood technologist continued to be in much request with the public and various Government departments and the day to day enquiries have increased considerably so much so that it is difficult to find time for the items of research down in the triennial programme.

Not much headway can be made with the limited staff available in the minor products section. Some progress is recorded in the

collection of information of important forest drugs and the cultivation of some of these was continued.

Chemistry Branch.—During the year under report investigations on *Derris*, which yields the valuable insecticide rotenone, have been continued. Of the several species examined *D. elliptica* from Assam has been found to contain over 2 per cent. of rotenone and may be classed amongst the good quality commercial *Derris*. This is important since it opens up the possibility of its cultivation on commercial lines. Investigation on other plants, reputed to act as fish poison, have also yielded interesting results.

The study of the *Laurinacea* fats has been continued with a view to find possible indigenous sources of laurie acid. This investigation assumes a certain amount of importance in view of the fact that sodium lauryl sulphate is being extensively employed as a base for new detergents.

A study of the fluorescence of wood under ultra violet light was made and the results in some cases are so striking that it is believed that systematic study of this phenomena correlating the nature of fluorescence with the constitution of timber and its anatomical structure may prove of value as an aid to identification. A coloured plate was published in the April number of the *Indian Forester*, 1935.

Mr. C. G. Trevor was President of the Institute during the year; he wishes to thank all members of the staff for their loyal co-operation in the advancement of forest research in spite of the somewhat limited funds available for the purpose.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

The following publications dealing with Experimental results obtained at the New Forest were published during 1934-35.

1. Cold weather planting in North India (Forest Bulletin No. 86).
2. Seasonal Progress of Height Growth in Trees (Forest Bulletin No. 88).
3. The effect of defoliation on the increment of teak saplings (Forest Bulletin No. 89).
4. A note on the use of paper tubes in planting (*Indian Forester*, January 1935).

Several of the investigations, however, are completed or sufficiently advanced to permit of useful deductions being drawn and they are being written up. Forest Bulletin No. 41 (" A note on the Weights of Seeds ") has been revised and is almost ready for publication.

(ii) Natural Regeneration.

The study of annual seed production and fertility of individual trees of *Anogeissus latifolia* (Expt. No. 44) was continued for the 7th year. Although seeding had been profuse, a severe hail-storm destroyed the seed crop almost completely before it was ready for collection.

The seed crop from individual trees of *Shorea robusta*, *Pinus longifolia* and *Terminalia tomentosa* (Experiment No. 10) were again recorded. 1934 was a good seed year for the last two species, but sal did not produce any seed. These records will have to be continued for several years more before conclusions can be arrived at with any precision.

(iii) Investigation on seeds.

(*a*) *Seed weighments and germination tests.*—During the year, 121 weighments were made including 26 new species and germination tests of 77 species were recorded.

(*b*) *Effect of size of seed on germination and growth of seedlings.*—The Experiment (No. 57) was carried out with *Terminalia tomentosa* in 1934. Seeds were graded into 4 diameter classes before sowings and the experiment shewed that the bigger the seed the better the result, both in respect of germination as well as in height growth.

(c) *Seed storage.*—Two species were added to the list under investigation, *viz.*, *Acacia catechu* and *Acer caesium.*

Seeds of *Acacia catechu* and *Bombax malabaricum* stored in gunny bags failed to germinate after 2 years; the seeds were found to have become rotten; seeds stored in sealed tins shewed 2 per cent. and 37 per cent. germination respectively. *Cinnamomum camphora*, after having been stored in gunny bags and in sealed tins for 2 years, failed to germinate in both cases. *Schleichera trijuga* and *Melia azedarach* gave 19 per cent. and 71 per cent. germination respectively after 2 years' storage in sealed tins, and 2 per cent. and 20 per cent. respectively after the same period in gunny bags.

In general, if seeds are to be kept they should in most cases be packed in sealed tins and not in bags.

(iv) Investigation on seedlings.

The morphological seedling studies as reproduced in *Troup's Silviculture of Indian Trees* were completed for 10 species, namely :—

Alstonia scholaris, Canarium bengalensis, Canarium strictum, Eugenia grandis, Swietenia macrophylla, Terminalia citrina, Terminalia paniculata, Bursera serrata, Tecoma undulata and *Boehmeria regulosa.*

(v) Investigation on trees and crops.

(a) *Seasonal course of height growth.*—The compilation work on 15 common Indian species has been published (*vide* Forest Bulletin No. 88). The investigation is being continued.

(b) *Phenological data.*—Observations were continued on 15 species. Preliminary compilation work has been done, but detailed analysis remains pending.

(c) *Inheritance of individual characters.*—Plants from seeds of known figured and unfigured *Terminalia tomentosa* trees of south India were raised in pots and planted out during the cold weather. Plants of *Pinus longifolia* raised from seed from trees with varying resin yielding capacity were planted with a view to determining whether the resin yielding capacity is a hereditary character.

(d) *Inheritance of climatic race characters.*—The All-India teak seed experiment, dealing with eleven origins, is being kept under observation for detailed study as regards phenology.

Ordinary C grade thinnings were carried out in *Acacia catechu* in both local and Burma origins. Burma origin is decidedly better than the local origin both in height as well as in diameter growth, and the noticeable difference in the colour of the foliage between the two origins

is maintained, the Burma plants being light yellowish green and the local plants dark green. The heartwood from both the origins is being examined by the Bio-chemist for cutch content.

(*e*) *Inheritance of physiological race characters.*—Small plantations of *Butea* and *Schleichera* forms reported to behave differently under lac culture were being kept under observation. Most of the plants have been badly affected by the last frost.

(*f*) *Soil quality class indicators.*—The quadrats in plantations of different important species in the Demonstration Area were continued, and mapping has been done up to date. The results await analysis.

(*g*) *Congestion in bamboo clumps.*—This experiment (No. 8) was laid out in the Experimental garden in July 1934, to study causes of congestion in bamboo. Fellings have been carried out according to prescribed treatments during the year under review and it is too early to give any conclusions yet.

(*h*) *Root competition.*—The investigation in sal and chir to study the effect of root competition of the suppressed and dominated stems on the dominant trees is still in progress.

(*i*) *Thinnings in young plantations.*—The two sets of plots laid out in the 1925 chir plantation and reported in last year are still under observation.

(*j*) *Pruning* versus *natural cleaning.*—50 comparable pairs of trees in the 1926 chir plantation area were selected, one set was pruned while the other was left to nature as a control.

(*k*) *Twist in Pinus longifolia.*—In the 1926 plantation of Kangra and Hazara origins, 20 plants of each origin were subjected in 1931, to each of the following treatments :—(1) Partial barking, (2) Topping, (3) Binding and (4) Control, to determine whether such mal-treatment causes any increase in the occurrence of twist.

A thinning of plants raised in 1928 by sowing seeds collected from selected twisted trees, was done in February 1935, and the saplings removed are being examined.

Pot plants raised in 1934 from X-ray treated seeds, with and without water treatment in 16 different ways, were planted out during the following cold weather in the Demonstration Area, with a view to ascertain whether X-ray treatment causes any twist in the plants so raised.

(vi) Artificial Regeneration.

Weather conditions affecting results were as follows :—

The 1933 rains were exceptionally good and well distributed. The following cold weather had a normal rainfall and a severe frost. The

1934 monsoon broke out on the 17th June and rains were regular up to September.

The 1934-35 cold weather was marked by a fairly good rainfall but a very severe frost occurred on the 15th, 16th and 17th January 1935, resulting in heavy casualties in plants, especially in teak, *Shorea robusta, Dalbergia latifolia* and *Terminalia tomentosa.*

(*a*) *Line sowings.*—Various species were tried both in shade and in the open in 1934, but only a few species, *viz.—Erythrina suberosa, Bauhinia variegata* and *Mallotus philippinensis* gave comparatively good results.

(*b*) *Rains entire transplanting in the open.*—The following species were tried in 1934, the survival percentage at the end of the year being given in brackets :—

Cedrela toona (75), *Lagerstroemia flos-reginae* (99), *Mallotus philippinensis* (63), *Pterospermum acerifolium* (97), *Terminalia arjuna* (79) and *Schima wallichii* (*nil*).

As regards plants put out in 1933, the following results indicate the survival percentage at the end of 1st and 2nd growing seasons respectively :—*Garuga pinnata* (90—35), *Lannea grandis* (98—92), *Pterocarpus marsupium* (87—63), *Machilus gamblii* (83—*nil*), *Soymida febrifuga* (95—*nil*) and *Cassia siamea* (61—*nil*). *M. gamblii* died due to hot weather of 1934, and *S. febrifuga* and *C. siamea* were killed back owing to severe frost during February 1934.

Since the last enumeration, the severe frost in January 1935 has killed all the plants down to the ground level except *Machilus gamblii* which had already died earlier in the hot weather of 1934 and *Soymida febrifuga* and *Cassia siamea* which had died in the 1934 frost or in the subsequent hot weather.

(*c*) *Rains entire transplanting in cleared lines.*—The following species were put out in 1934, the survival percentage at the end of the year being given in brackets :—

Cedrela toona (69), *Lagerstroemia flos-reginae* (100), *Mallotus philippinensis* (83), *Pterospermum acerifolium* (91) and *Schima wallichii* (15).

For the species tried in 1933, the following figures shew the fall in survival percentage during the 2nd growing season :—

Schleichera trijuga (76 to 44), *Cassia siamea* (40 to *nil*) and *Machilus gamblii* (98 to 70). *Cassia siamea* was all killed out by the frost of February 1934.

(*d*) *Winter entire transplanting in the open and cleared lines.*—It was mentioned in last year's report that out of the six species put out in December 1932 only three survived up to December 1933. Further

observation a year after (December 1934) showed that the survival percentage of *Chloroxylon swietenia* dropped from 5 to 0, of *Lannea grandis* from 47 to 41 and of *Soymida febrifuga* from 26 to 19. The species reported to have been added in January 1934 (*Pterospermum* and *Terminalia* spp.) did not survive on account of frost.

The following species were planted out in January 1935, *viz.*— *Eugenia jambolana, E. operculata, Litsaea polyantha, Terminalia chebula* and *Terminalia paniculata.*

All these species, except *T. chebula,* were also tried in cleared lines.

(*e*) *Winter stump planting in the open and cleared lines.*—The only three species reported last year to have survived of the 1932 December experiments showed the following percentage of survivals at the close of 1933 and 1934 (figures in brackets) :—*Erythrina suberosa* (84 to 55), *Bauhinia retusa* (74 to 64), *B. variegata* (64 to 64).

In January 1934, the following species were put out and survival percentage in November 1934 is given in brackets against each species :—

Ougenia dalbergioides (24), *Stereospermum suaveolens* (89), *Celtis tetranda* (51), *Cedrela toona* (38) and *Eugenia operculata* (*nil*). The last species was not a success on account of frost.

The following seven species were added during January 1935 :— *Pterospermum acerifolium, Chickrassia tabularis, Acacia modesta, Litsaea polyantha, Prosopis juliflora, Trewia nudiflora* and *Acacia catechu.* Of the four species tried in cleared lines in January 1934, only *Ougenia dalbergioides* survived (21 per cent.).

Species planted out in January 1935 in the open, were also tried in cleared lines with the addition of *Chloroxylon swietenia.*

(*f*) *Rains stump planting in the open.*—The following results were obtained at the end of the second growing season with species tried in 1933, the figures in brackets giving survival percentage at the end of the 1st and 2nd seasons respectively :—

Grewia elastica (97—94), *Olea glandulifera* (57—*nil**), *Terminalia chebula* (97—78), *Xylia xylocarpa* (66—*nil**), *Eugenia operculata* (100—100), *Ougenia dalbergioides* (76—62), *Shorea talura* (91—*nil**), *Erythrina suberosa* (93—45), *Acacia arabica* (76—*nil**) and *Garuga pinnata* (98—55).

The species put out during the rains of 1934 are mentioned below, giving their survival percentage at the end of the year in brackets :—

Olea glandulifera (60), *Cassia siamea* (86), *Stereospermum suaveolens* (Stumps 99, root sections 97), *Chloroxylon swietenia* (83), *Mallotus*

*Where the survival percentage at the end of the 2nd year has been shown as *nil* with an asterisk the wholesale casualty was due to the severe frost of February 1934

philippinensis (98 in one case and 76 in another), *Terminalia chebula* (85) and *Prosopis juliflora* (79).

The last observation during February-March 1935 showed that most of these species have been wholly or partially frosted during the last cold weather. How far these will revive will be watched with interest.

(*g*) *Rains stump planting in cleared lines.*—*Phoebe hainesiana* and *Mallotus philippinensis* were put out in July 1934, survival percentage in December 1934 being 70 and 89 respectively. As regards height growth, there is a progressive diminution for each date later than the 12th May. The indications are, therefore, that stumps should be planted at the earliest date at which a reasonably high percentage of success can be obtained, namely three weeks before the break of the rains in this experiment. By so doing an increase of over 80 per cent. in height growth is obtained in the first season with correspondingly greater chances of establishment and reduced casualties in the second and subsequent seasons.

(*h*) *Storage of stumps before planting.*—Experiments were carried out on the lines of the previous year. 250 teak stumps of different diameters, prepared on 3rd July 1934, were planted out in comparable lots of 50 stumps after an exposure up to 20 days to sun, rain and wind, on a cement floor in wire shelter. There was more or less rain on 14 of the 20 days. At the end of the growing season the survival percentage was 94, 90, 78, 56 and 18; and corresponding average height 7·1″, 6·7″, 6·3″, 5·1″ and 4·0″, for stumps exposed for 0, 4, 8, 13 and 20 days respectively, further confirming last year's (as well as earlier) conclusions as to the exceptional vitality of teak stumps.

For 250 teak stumps stored and similarly planted out in 1933 (*vide* last year's report) the survival percentage at the end of the second growing season was 98, 100, 98, 86 and 70, with corresponding average heights of 40·6″, 42·7″, 38·6″, 37·7″ and 32·8″ respectively.

(i) *Early planting of stumps without irrigation.*—Teak stumps have been planted fortnightly since the 15th January 1935, both in the open as well as in cleared lines. It is too early to note results yet.

For teak stumps planted fortnightly from the 27th January 1934 to 27th September 1934, the survival percentage after one growing season was 48, 44, 44, 64, 52, 56, 64, 76, 88, 100, 92, 92, 84, 80, 72, 16 and 0 with corresponding average heights 12·8″, 13·9″, 18·2″, 16·6″, 15·5″, 14·5″, 14·9″, 17·7″, 13·9″, 11·6″, 9·7″, 7·9″, 5·0″, 3·7″, 3·0″, 2·0″ and 0″.

It would appear from the above results that stumps planted between the 27th May and the break of rains (21st June) give much higher percentage of survival than those planted out earlier, *e.g.*, February-March.

(*j*) *Comparison of nursery stock and natural seedlings*: *Eugenia jambolana.*—For plants raised from the nursery and planted out in 1932, the survival percentage at the end of each growing season varied from

90 to 75 to 63 up to the third season; for those of natural seedlings planted out the same time the percentage varied from 90 to 52 to 45, there being no significant difference in height.

(*k*) *Comparison of nursery and forest stumps.*—*Eugenia jambolana* was tried in 1933. At the end of the 1st growing season survival was cent. per cent. for both, but at the end of the second growing season the percentage fell to 80 and 90 respectively; the average height of the nursery grown stumps was worked out to be 13·6″, while that of the forest stumps was 17·9″.

(*l*) *Comparison of sowings, transplants and stumps.*—The following is the record of observations at the end of the third growing season for the four species tested in 1932:—

Gmelina arborea was concluded in August 1934 on account of its having been attacked by some unknown disease still under investigation.

Tectona grandis was planted out as entire transplants and stumps in standard pits and only as stumps in crowbar holes. As regards *Acacia catechu*, *Bauhinia variegata* and *Bombax malabaricum* raised by direct sowing, entire transplanting and stump planting, all in pits, the following tabular statement summarises their results at the end of 1st, 2nd and 3rd growing seasons.

Species.	Method (sowing or transplanting.)	Survival percentage.			Average height in inches at the end of the 3rd year.
		1st year.	2nd year.	3rd year.	
Tectona grandis .	Entires in pits .	70	37	37	52·9
	Stump planting in standard pits.	98	98	98	83·1
	Stump planting in crowbar holes.	93	92	92	79·4
Acacia catechu .	Direct sowing .	93	83	80	60·8
	Entire transplanting	83	80	80	61·6
	Stump planting .	68	43	43	82·6
Bauhinia variegata .	Direct sowing .	100	100	98	90·5
	Entire transplanting	95	87	87	66·6
	Stump planting .	100	98	98	85·1
Bombax malabaricum	Direct sowing .	95	60	60	11·3
	Entire transplanting	95	58	58	10·0
	Stump planting .	95	88	88	24·3

Two more species, *viz.*, *Eugenia jambolana* and *Stereospermum suaveolens* were added in July 1934. Their survival percentage after one growing season compared as follows :—

Eugenia jambolana 93 for direct sowing, 60 for entire transplanting and 78 for stump planting.

Stereospermum suaveolens 53, 98 and 60 for entire transplanting in crowbar holes, stump planting in standard pits and entire transplanting in standard pits respectively.

(*m*) *Araucaria plantations.*—The small plantation of *A. cunninghamii* raised in June 1932 is in good condition having already attained a maximum height of 7′-0″.

Another small plantation of *A. bidwillii* was started in July 1929 but most of the plants were damaged by white ants during 1930-31. Those that survived are growing quite well, having attained a height of 9′-6″.

(vii) Nursery work.

The seed crop on trees especially in the Dun Valley was fairly good during the year. Stock of various species was raised for use in the Experimental Garden. Experiments with different types of nursery bed shades (providing different degrees of shade) to study their effect on germination and growth were carried out in the nursery with the following species.

Adina cordifolia.—The conclusions drawn are as follows :—

(*a*) In the unshaded bed, germination commenced last of all with the result that plants were very small.

Germination in shaded beds commenced fairly early, and was completed at the same time.

(*b*) Germination was best under a tin shade, seedlings were so dense as to damp off in patches where they were very thick.

(*c*) The bed under a batten shade was thinly stocked all over due to excessive rain getting in ; it was better stocked than the one under thatch.

(*d*) The bed with a thatch shade started fairly well but later on the seedlings were almost entirely destroyed by drip.

(viii) Miscellaneous.

(*a*) *Effect of defoliation on diameter increment of teak.*—The results of this experiment have been published in Forest Bulletin No. 89. It was found that three defoliations in a season resulted in a 60 to 70 per cent. loss of normal increment in height, basal area and volume. A

fourth defoliation resulted in a 50 per cent. mortality and a loss of 65 to 75 per cent. of the normal increment. Further losses of approximately 50 per cent. occurred in the second year in trees defoliated three times in two years in succession.

(*b*) *Method of working bamboos for maximum sustained yield in quantity and value.*—All the provincial plots, initiated by the Experimental Assistant in co-operation with the Provincial Research Officers, are being maintained by the latter on approved lines. Notes on observations or cultural operations from time to time are being passed on to the Forest Research Institute for record and necessary compilation. Only the plots within the Hoshiarpur division in the Punjab were remeasured by a field Assistant of the Central Silviculturist during the year.

(*c*) *The all-India teak seed origin investigation.*—A summary of the results obtained so far from the all-India teak seed origin experiments organised by the Forest Research Institute has been compiled and was circulated at the time of the 4th Silvicultural Conference held in October 1934 (*vide* pages 119-122 of the printed proceedings of the said conference).

(ix) Reclamation and afforestation.

The year under review proved fatal to teak, *Dalbergia latifolia* and *Terminalia tomentosa* in the experimental area on account of frost. Even local species like sal, *Bombax malabaricum* and *Albizzia procera* suffered severely.

Four compartments in which *Gmelina arborea* had been killed out by disease were given out for taungya cultivation during 1933. The compartments were sown in lines 10′ apart with *Acacia catechu* during the rains of 1934.

(*a*) *Sal working circle.*—Two compartments of about 1·5 acres were sown with Gorakhpur large and small seeded sal. The plants are in a healthy condition and were not affected by the frost as they had been given adequate protection by shades during the winter.

Blanks occurring in compartments containing sal plants of local, Haldwani, and Hoshiarpur seed origins were filled up by direct sowing during the last rains.

(*b*) *Pinus longifolia working circle.*—Casualties were replaced with Hazara, Nainital and Lansdowne origins during the rains.

A light C-grade thinning was carried out over the whole area of the 1925 and 1926 plantations, and a systematic pruning of selected stems was done in 6 of these compartments during the cold weather of 1934-35.

(*c*) *Rosewood working circle.*—The attack of *Ascomycete fungi* on rosewood and the very severe frost of January 1935 have again damaged

the plants very considerably. Constant failures with this species during the past few years have led to the conclusion that no further attempts at growing it here are justified. Natural sissoo will be allowed to take its place.

II.—STATISTICAL WORK.

(i) YIELD TABLES.

Stand tables giving the distribution of trees by diameters in crops of different ages were prepared for *Shorea robusta* coppice to supplement the existing yield table.

The records of a number of comparative thinnings sample plots in Bihar and Orissa and Madras were analysed for initial comparability. The statistical problems connected with the Madras set have been put before Professor P. C. Mahalanobis of the Presidency College, Calcutta, for his opinions regarding the most satisfactory methods of analysing them.

Von Wulfing's yield tables for teak plantations in Java were converted from metric units to feet and inches, they were adapted to the standards and mode of presentation of the Indian teak plantation yield tables and were published as Forest Bulletin No. 87.

The routine work of computing the data in the standard sample plot files received from the provinces occupied as usual most of the time of the computing staff. 275 files were received during the year for computation, and 514 plot files were actually computed, thereby considerably reducing arrears.

The total number of sample plots maintained is steadily increasing as the following statement shows.

Year.	No. of permanent sample plots maintained.
1930-31	1,246
1931-32	1,327
1932-33	1,475
1933-34	1,475
1934-35	1,502

Of these plots 364 are in the United Provinces and 326 in Burma, the remainder being in other parts of British India. In addition to the above 332 temporary sample plots have been measured up to date.

(ii) VOLUME TABLES.

A local volume table for *Pterocarpus santalinus* giving heartwood outturn was compiled for the Chamala Valley, Chittoor Division, Madras.

Single tree data from the Punjab for standard volume measurements and commercial volume measurements were computed for 678 trees of 5 different species.

Tables for solid (πr^2) volumes of logs of lengths up to 30 feet and mid-diameters up to 36″ were prepared, and a table of bark percentages corresponding to different diameters over and under bark was compiled.

(iii) Miscellaneous.

In connection with the Silvicultural Conference held in October/November 1934 suggestions for amendments to the Statistical Code were collected from all provinces, critically examined, and then discussed at the conference. The resulting decisions will be published as corrections to the Code. In this connection the results of an investigation into the precision of the standard Indian sample plot methods were published in the Indian Forester (October 1934).

A considerable amount of statistical analysis of data from the experimental section was done during the year including the computation of the figures relating to the effect of defoliation on the increment of teak.

Miscellaneous.

(i) Photographic section.

The routine work dealt with compares with previous years as follows:—

Year.	Negatives made.	Prints made.	Lantern slides made.	Colour photos.
1932-33	677	2,276	44	..
1933-34	1,095	2,271	400	..
1934-35	932	3,420	130	18

Of the new negatives, 150 were photographs taken by the Silviculturist on tours in Bengal and Ceylon, 2 by the Experimental Assistant in the Central Provinces, and 25 by the Mycologist at Chakrata. 245 photographs concern the Timber Testing Section and a further 221 were photographs taken for other branches and sections of the Institute. 283 negatives were sent by the Silviculturists of Madras, Kashmir, United Provinces and by the Forest Research Officer, Bihar and Orissa, to be lodged in the Forest Research Institute collection. Many of these photographs were of great interest and the increased co-operation of the Provincial Silviculturists and other forest officers in sending such photographs is much appreciated.

Out of the 3,420 prints made, the silvicultural collection has been increased by 390 making the total 4,203 in the specific series and by 395 to 3,372 in the general series. 866 prints were prepared for different provinces and native states. 351 prints were received directly or indirectly from provinces. 37 prints were exhibited at the 4th Silvicultural Conference, and an exhibit was given demonstrating correct and incorrect technique in forest photography. 88 photographs were used as illustrations in various publications.

An attempt was made to demonstrate the possibilities of colour photography by different screen plate processes at the Silvicultural Conference, but the results were not very satisfactory probably owing to inexperience and faulty manipulation.

130 lantern slides were prepared and added to the collection which has now become fairly comprehensive. 56 slides were sent for by the Silviculturist, U. P., and the Principal, Madras Forest College and a number of slides were lent to the Divisional Forest Officer, Chittagong Division, to show at an industrial exhibition and for local propaganda purposes. The Range Officer of the Demonstration Area of the Institute was sent to Kotdwara where he delivered a public lantern lecture on the Utility of Forests illustrated by slides from the Forest Research Institute collection.

A number of stereoscopic photographs were added to the collection during the year. It is felt that greater use might well be made of stereoscopic methods which are particularly suitable for forestry subjects.

A successful cinema exhibition was given during the Silvicultural Conference, using the Forest Research Institute sub-standard projector and a second projector kindly lent by Mr. Shebbeare. The films shown were mostly taken by forest officers of forest subjects, and included a purely silvicultural film on " Making a teak Plantation " by Mr. M. F. Bridge, Divisional Forest Officer, South Coimbatore, Madras. Efforts are being made to start a collection of sub-standard films of forestry subjects and offers of a few films have been received. It is hoped that all forest officers who own cinema cameras will co-operate in making this collection as comprehensive and interesting as possible.

(ii) Records.

Owing to lack of an assistant able to read German and French the referencing of foreign literature fell seriously into arrears during the year. The Silviculturist unaided cannot possibly find time to read or translate more than a fraction of the articles in foreign languages that call for scrutiny with the result that many have had to be referenced by titles only without even a summary in English.

Some progress was made in the marking for ledgering of Working Plans by the Statistical Assistant to whom this work was given. 109 plans were marked, but the cutting up and filing of these has become a big task and will take some time. All publications on Indian Forestry were abstracted as usual for " Biological Abstracts."

The number of new specific ledger files opened during the year was 23 bringing the total up to 1,203, the corresponding figures for the general ledger files being 7 and 438. The compilation of a note on the forest types of India is nearing completion and will be published shortly. The question of compiling a general manual of Indian Silviculture which would be largely based on the general ledger files is under consideration.

26 new books were added to the silvicultural library during the year including 17 working plans, bringing the total up to 633 volumes and 464 bound periodicals. The usual list of important additions was circulated with brief abstracts to Provincial Silviculturists.

(iii) Working Plans.

Notes were written on the Sadiya draft working plan and the suggestions made have been generally adopted in the plan.

(iv) Museum.

The model of a sample plot in Deodar forest referred to last year has been completed to a scale of 1/40th of actual size. The model of the irrigated plantation of *Dalbergia sissoo* representing the plantations in the Punjab deserts was reconstructed and improved, and the construction of a working model to demonstrate the influence of forest cover in preventing erosion has been commenced. A few of the photographs in the museum were hand-coloured by the Artist.

(v) Staff and touring.

During April to June 1934 the Silviculturist made a tour in North Bengal in Darjeeling, Kurseong and Kalimpong Divisions where he visited the hill taungyas.

The post of the Silviculturist was held in abeyance from the 14th November 1934 to the 20th February 1935 during which period his services were lent to the Ceylon Government to advise them regarding their future forest policy. The post of Experimental Assistant also fell vacant from 18th November 1934 when Mr. P. N. Deogun reverted to his province, and was not filled until 1st April 1935 when Mr. J. N. Sen Gupta succeeded him.

The Statistical Assistant laid out an experiment with 'Atlas' tree killer solutions at Asarori in Dehra Dun division, and also took full

measurements of the *Dalbergia sissoo* sample plot No. I at Chila in Lansdowne Division, United Provinces, which was to be clearfelled, the object being to see how far the volume arrived at by our sample tree method agrees with the actual volume of the plot.

Ranger Bachaspati Nautiyal of the Demonstration Area was transferred to the United Provinces and was succeeded by another United Provinces Ranger Hari Krishan Madhwal. No other changes in staff have taken place.

(vi) Silvicultural Conference.

The chief event of the year was the 4th Silvicultural Conference held in the Forest Research Institute from 29th October to 3rd November 1934. Thirty-five delegates attended from all provinces of India and Burma and from the native states of Chamba, Hyderabad (Deccan), Kashmir, Mysore and Travancore. The agenda included 26 items, several of them sub-divided, and almost the whole field of silvicultural work was covered. Important decisions were reached regarding research methods and many other matters.

CHAPTER III.—BOTANY BRANCH.

1. *Systematic Botany.*—The systematic study of important timber trees of the family *Dipterocarpaceæ* was continued during the year. The final proof of a paper in the Indian Forest Records on *Dipterocarpus macrocarpus* Vesque, the two Burmese trees *Scaphula glabra* Parker and *Anisoptera oblonga* Dyer, and the two South Indian *Hopeas*, *H. glabra* W. & A. and *H. wightiana* Wall. has been corrected. Further work on the trees of this family was done and the following five species will now be dealt with, three allied species of *Shorea*, *S. assamica* Dyer, *S. floribunda* Kurz and *S. sericeiflora* Fisch. & Hutch., two little-known Burmese *Hopeas*, *H. oblongifolia* Dyer and *H. helferi* Brandis. The two South Indian species of *Dipterocarpus*, *D. indicus* Bedd. and *D. bourdilloni* Brandis are also under investigation to complete the study of the Indian species of that genus.

Further examination of the material of the Indian *Terminalias* of the section *Pentaptera* was continued. None of the first lot of herbarium specimens sent to Berlin for comparison agreed satisfactorily with Roth's type of *Terminalia alata* and *T. crenulata* and a further lot of 23 herbarium sheets has been sent and the report on them is awaited. The genus has been found to be a difficult one as some overlapping of specific characters is evident and hybrids occur.

A note on the systematy of some Indian and Burmese *Dillenias* hitherto confused in herbaria and on one of the little-known Burmese bamboo *Melocanna humilis* Kurz have been completed and submitted for publication in the Indian Forester.

A paper on some new and little-known plants from Kumaon, in which two new species, *Viscum osmastonii* and *Phlogacanthus lambertii*, were described and figured and a third species, *Sinomenium acutum* Rehder and Wilson, was figured and recorded for India, was published in the Indian Forester and also a paper on the Vegetation of the hill-tops of Tenasserim.

2. *Herbarium.*—During the year 3,560 herbarium sheets were incorporated. Of these nearly 1,200 were from the Malayan collections previously donated by the Superintendent of the Royal Botanic Garden, Calcutta, about 750 were from collections made by the Forest Botanist and his staff and 646 were received from the Director of the New York Botanic Garden. The latter include many duplicates of the collections made by Dr. W. N. Koelz in the Sutlej valley in 1930 in connection with the Himalayan Research Institute of the Rœrich Museum and are a welcome and valuable addition to our herbarium. The remainder was made up chiefly of collections received on an exchange basis or by dona-

tion from the Director of the Natural History Museum, Stockholm, the Herbarium of the Temple University, Philadelphia, the National Herbarium, Victoria, Melbourne, the Imperial Forestry Institute Herbarium (Southern Nigeria collections), from Mr. H. C. Gill, I.C.S. (Spiti collections), Mr. R. N. Parker, I.F.S. (Punjab collections) the Forest Botanist, Burma (duplicates from collections made by Brigadier C. C. Foss at Maymyo), Mr. J. C. Nath, I.F.S. (Sunderbans collections) and numerous smaller collections from forest officers and others from various parts of India sent in for identification.

The following were distributed either as donations or on an exchange basis :—

Botanic Garden and Museum, Berlin	289
Maymyo herbarium	190
Royal Botanic Gardens, Edinburgh	320
New York Botanic Garden	145
Temple University, Philadelphia	34
Harvard University, Jamaica Plain, Mass., United States of America (Arnold Arboretum)	75
Gray Herbarium, Harvard University, Mass., United States of America	106
Naturhistoriska Riksmuseet, Botaniska Avdelningen, Sweden	81
School of Forestry, Victoria, Australia	18
TOTAL	1,258

117 herbarium sheets, chiefly *Avicennia*, *Meconopsis* and *Phœbe* were sent out on loan for study and 119 were sent to various herbaria for confirmation of identifications or critical comparison with types.

The re-arrangement of the foreign (non-Indian) collections in the herbarium was continued and the work has now progressed as far as the Compositae (Bentham & Hooker arrangement) representing about half the herbarium. This work is done by the Herbarium Clerk in addition to his usual routine herbarium work.

3. *Library.*—During the year 48 volumes of periodicals and 45 volumes of books were added to the library. The work of card indexing references to literature on select botanical subjects contained in the volumes of our library was undertaken and has nearly been completed. This work entailed the examination of most of the periodicals and other books in the herbarium library and was done chiefly out of office hours by Messrs. A. Hafiz Khan, Mukat Behari Raizada and the Forest Botanist. The want of such an index has been keenly felt recently and the benefit of the work that has been done is already appreciable. It will be completed as early as possible.

4. *Identification of specimens.*—1,365 specimens were identified during the year. These include the identifications of 169 specimens collected by the Forest Botanist when on tour in Bengal and communicated to the Conservator of Forests, Bengal in connection with the determinations of trees along linear sample plots. The remainder are chiefly the collections sent in by the Forest Botanist, Burma, Messrs. V. S. Rao and J. C. Nath, I.F.S., Bengal, Dr. N. L. Bor, I.F.S., Assam, Mr. H. G. Champion, I.F.S. (specimens from the Darjeeling Himalaya), the Silviculturist, Forest Research Division, Punjab and the Divisional Forest Officer, Chittagong Hill Tracts. Numerous smaller collections were sent in by Research and Divisional Forest Officers from various parts of India. These identifications are done in the nature of routine work and take a large part of the time of the Forest Botanist and his assistant.

Tours.—The Forest Botanist toured in the Parbatti valley of the Kulu division during the months of May and June 1934. A large number of soil samples were taken for the determination of their Ph. value in connection with the problem of the regeneration of Spruce and Silver fir with a view to ascertaining the bearing of this factor on their regeneration; a large collection of botanical specimens was also made at altitudes ranging from about 6,000 to 14,000 feet representative of the flora of the locality in flower at that time of the year. A second tour was made in the Chittagong Collectorate and Hill Tracts with the Conservator of Forests and Silviculturist, Bengal, in connection with the identification of trees on the linear sample plots and other trees of forest importance. A large collection of herbarium specimens was also made for the Dehra Dun herbarium and exchange purposes.

5. *Supply of seed.*—The demand for small authentic samples of seed continues and many indents of this nature from various scientific departments and institutions, chiefly on an exchange basis, were complied with. Twenty three large indents aggregating some 3,600 pounds of seed were also complied with during the year. The seed mostly in demand was that of *Pinus longifolia* of which a large quantity was shipped to the Director of Forestry, Union of South Africa. The other kinds supplied were *Pinus khasya* to South Africa, *Cupressus torulosa* to Ceylon, *Tectona grandis* (Malabar, Godavari and Central Provinces types), *Dalbergia latifolia, Pterocarpus marsupium* and *Acacia arabica* to Java, *Ougeinia dalbergioiodes* to Portuguese India, *Terminalia chebula* to Cutch State and *Leucœna glauca* to Bengal.

6. *Arboretum, Fruticetum and Botanic Garden.*—Planting in the arboretum continues to make good progress about 250 plants having been put out during the year. Among these were 15 species of *Eucalyptus* which were planted out in groups of which *E. torelliana, E. tereticornis* and *E. naudiniana* have already made excellent growth. In

the planting up of avenues good progress has been made in the replacement of exotics which are not doing well at New Forest with local ornamental trees and such exotics as have been tried and are known to do well under our conditions. The north and south avenue, north of the east wing of the main building which was planted up with *Mimusops hexandra*, *Afzelia quanzensis* and *Melaleuca styphelioides* has been replanted with *Poinciana regia* as the first-mentioned species do not show promise of doing well; the *Chorisia* avenue has been interplanted with *Eucalyptus rostrata* in the hope that the shade afforded by the *Eucalyptus*, which are doing well, will be beneficial to the *Chorisias* most of which have not done well.

Work in the new botanic garden has been taken well in hand and during the short period of eight months, since its inception, about 450 plants representing about 150 genera and 60 families have been planted out. These plants have been raised in our nursery or obtained by transfer from the old fruticetum which will be gradually abandoned. The site of the new botanic garden is an excellent one and very suitable for the formation of a garden for economic, aesthetic and educational purposes.

This winter unusually severe frost accompanied the cold wave that was experienced in Northern India and damaged many plants in the arboretum and botanic garden. Little or no damage was however done to such plants as *Taraktogenos kurzii*, *Xylia xylocarpa*, *Acrocarpus fraxinifolius*, *Aesculus punduana*, *Acacia xanthophlœa* (the green-barked Acacia of the Transvaal), *Enterolobium timbouva* and others.

In addition to some 700 plants raised for planting out in the arboretum and botanic garden about 500 more were also raised and distributed for planting in the residential grounds at New Forest and in the adjoining Indian Military Academy and elsewhere.

The following plants were recorded as having flowered for the first time at New Forest:—*Aleurites cordata* R. Br., *Euclea undulata* Thunb., *Peltophorum africanum* Sond. *Bauhinia corymbosa* Roxb., *Chilopsis saligna* D. Don., *Catalpa kaempferi* S. & Z., *Dalbergia hupeana* Hance, *Ligustrum nepalense* Wall., *L. compactum* Hk. f. & Th., *Stereospermum glandulosum* Miq., *Pennisetum purpureum* Schum., *Cephalotaxus drupacea* S. & Z., *Citrus nobilis* Lour, *Nephelium tomentosum* F. v. M., *Joannesia princeps* Vell, *Rhus viminalis* Vahl., *Gleditschia sinensis* Lamk., *Lithraea molleioides* Engel., *Tristania conferta* R. Br. and *Greyia sutherlandii* Hk. & Harv.

7. *Miscellaneous.*—Many enquiries of a technical nature were answered and advice was given on botanical matters to forest officers and others in various parts of India.

8. *Staff.*—The post of Forest Botanist was held throughout the year by Mr. C. E. Parkinson who was assisted by Mr. Mukat Behari Raizada, Lower Grade Assistant.

The mycological work reported on below was carried out by Dr. K. D. Bagchee, Mycologist, Mr. A. Hafiz Khan, Upper Grade Assistant, and Mr. R. N. Chatterjee, Laboratory Assistant.

MYCOLOGY.

9. *Shisham root disease.*—Observations were made on the shisham trees inoculated with Fusarium sp. Cultural studies of *Fusarium* sp. *Ganoderma lucidum* and *Polyporus gilvus* were continued. A report on the investigation of the shisham root disease is being prepared.

10. *The die-back disease of Gmelina arborea.*—This problem has been transferred to the Forest Entomologist with a view to finding out the part played by various insects *viz.*, Tingid bugs, Alcides gmelinae and Calopepla leayana, in the mortality of *G. arborea* in the demonstration area at the Forest Research Institute. Cultural work on the *Coniothecium* sp. and its Phomastage (pycnial sori) isolated from the *Gmelina* shoots was continued.

11. *Peridermium himalayense and Cronartium himalayense.*—This rust was found on *Pinus longifolia* in the Dharmigadh and Dhanrash blocks, Bawar range, Chakrata division in May and June and the *Cronartium* stage on *Swertia alata* in the same blocks in September and October. The observations made in the Almora division have thus been verified.

Peridermium indicum on Pinus excelsa and Cronartium sp. on Ribes rubrum.—

Ribes plants were successfully inoculated in three different localities in the Chakrata division during May and June with *Peridermium indicum* received from Kulu division. Uredo inoculations were also done and this stage repeated and the teleutostage reproduced. A large number of cross inoculations were done on *Pinus excelsa* with the Cronartium sp. (teleutostage) from Ribes in the same forest during September and October, with the object of reproducing the aecidialstage on Pine. The results are awaited.

Peridermium cedri, P. brevius, P. Thomsoni, P. piceae and Peridermium sp. on Abies pindrow.—A collection of a large number of rusts on various broad-leaved species was made in the Chakrata division, during two seasons, May-June and September-October, in order to select the probable alternate host of these fungi. This collection is now under examination. A detailed study of the mode of parasitism of these coniferous needle rusts and the morphology of the rusts on various broad-leaved hosts, some of which are likely to be the alternate hosts, is also in progress.

12. *Damping-off disease of seedlings of forest importance.*—Damping-off records and the germination data in natural garden soil, garden soil and sand mixtures and garden soil, sand and manure mixture, have been maintained for three successive years for *Soymida febrifuga*, *Terminalia tomentosa*, *Dalbergia latifolia*, *Dalbergia sissoo* and *Gmelina arborea*. The cultural study of the organisms responsible for damping-off has been continued.

13. *Cultural study of wood-rotting fungi and their pathogenecity.*—The wood-decomposing properties of (*a*) *Ganoderma lucidum* (*b*) *Polyporus gilvus* (*c*) *Fomes annosus* (*d*) *Polystictus versicolor* (*e*) *Polystictus sanguineus* and (*f*) *Schizophyllum commune* on blocks of wood have been recorded for 4 and 8 months.

Inoculations were done with *Fomes annosus* and *Armillaria* sp. on *Pinus excelsa* and *Cedrus deodara* in the Chakrata division during two seasons in May-June and after the rains in September-October. The results are awaited. Besides the above the following cultures of wood-rotting and dry-rot fungal organisms for cultural study and inoculation experiments were also maintained :—(*a*) *Polystictus tabacinus* (*b*) *Fomes rimosus* (*c*) *Trametes pini* (*d*) *Fomes tricolor* (*e*) Dry-rot fungus on *Dipterocarpus* sp. (*f*) Dry-rot fungus in *Amoora wallichii* (*g*) Dry-rot fungus in *Cedrus deodara*.

14. *Sal root disease including Polyporus shoreae.*—A large number of specimens of rots and various *Polyporaceae* from the sal forests of Assam and Bihar and Orissa were examined. Attempts are being made to raise cultures of these organisms in order to study their pathogenecity on sal. A recent out-break of sal mortality in Bihar has engaged our attention and it is proposed to do field work in connection with the study of the parasitic fungal flora of that region.

15. *Routine work.—Herbarium.*—The rust flora of the Kagan division and the *Polyporaceae* of the Kumaon and Chakrata forests have been identified and incorporated, while the rusts of Kumaon and Chakrata are being studied. A collection of root-rotting specimens and dry-rots have also been made for the museum.

The examination of treated sleepers of Deodar from the North Western Railway for fungal rot received detailed attention. Deodar rots from Kashmir, dry rot on Deodar from the Punjab and a large number of sal rots were also examined in detail.

The champ (*Michelia champaca*) disease from Kurseong was investigated and a large number of inoculations were done with *Fusarium* sp. isolated from the dead twigs of the plant to corelate the die-back in the forests with fungus attack.

A serious outbreak of canker disease of *Dalbergia latifolia* saplings in the demonstration area at the Forest Research Institute was noticed;

the organism was isolated and healthy trees were inoculated with the cultures. The results are awaited.

The Ph. value of a large number of soil samples form Kulu division were determined.

A large number of cultures of *Ascomycetes* and *Imperfect fungi* are maintained with a view to study their pathogenic behaviour.

CHAPTER IV.—FOREST ENTOMOLOGY.

Insects of Sal.

Measures for the protection of the timber of dying sal in Haldwani division, United Provinces were successful in reducing the incidence of secondary borers to a degree at which no economic damage occurred. The causes of dying-off were investigated and the relative importance of fungi and insects defined; the general question was discussed in an article in the *Indian Forester* on the role of insects in the dying-off of sal.

An outbreak of *Hoplocerambyx spinicornis* occurred in Kalagarh division, United Provinces affecting about 500 trees. This is the first occasion for a long time that an attack by this borer has been of sufficient extent to require a deviation from the working plan, and was probably caused by the excessively high rainfall of June-August in 1933 and 1934.

Control measures against *H. spinicornis* were in force in sal forests in Kurseong division, Bengal during 1934-35, necessitated by increase following cyclone damage. Trap trees yielded about 300 beetles per tree at a cost of about 5 annas a hundred.

Insects of Teak.

Phassus malabaricus.—Additions were made to the list of food-plants of this teak borer. Attack by it on seedlings and saplings of plantation teak is in the nature of an invasion from the main breeding-grounds in miscellaneous shrubs and underwood, and is preventable by destruction of these alternate food-plants in conjunction with weeding operations. Attempts to establish the insect in the Insectary at Dehra Dun were unsuccessful.

Defoliators.—A definite conclusion of research on the defoliation of teak is that control must be achieved and maintained by means of biological methods. Direct action (spraying, trapping, direct destruction, etc.) can never be regarded as a practical measure until plantations can be reliably patrolled for the detection of incipient outbreaks and spraying operations can be carried out with exceptional celerity. The principles of the biological control of defoliators in pure teak stands have been explained in an article in the *Indian Forester*. Briefly the main points are (i) subdivision of large blocks of pure teak by means of pre-existing forest rather than of newly created stands of other species or of mixtures; (ii) establishment of a varied flora under the teak canopy at the outset by retention of coppice re-growth and miscellane-

ous seedlings rather than by the artificial introduction of selected species at a later stage; (iii) elimination of harmful plants including in this category the alternate food-plants of defoliators; (iv) maintenance of an understorey in older stands with regard to its value as a shelter for beneficial animals and as an obstacle to defoliators; (v) introduction of parasites and predators after careful assessment of the factors of the locality. When all the agencies of biological control are working effectively defoliation will be restricted to a light grade of skeletonisation and widespread epidemics will not occur.

The establishment of a suitable plant community inimical to defoliators is the forest officer's task; the assessment and stabilisation of control by natural enemies is main object of entomological research. In this connection a tour was undertaken in teak growing divisions in Bihar and Orissa and the Central Provinces and a survey made of the distribution and incidence of parasites and predators of the chief teak defoliators. A collector also visited Ceylon. Special attention has been paid to the discovery of alternate hosts of parasites of teak pests. Information is now extensive enough to justify the choice of species of parasites of *Hyblaea puera* and *Hapalia machaeralis* for introduction to localities where they are absent.

Numerous new records were made of the lepidoptera feeding on plants associated with teak and additional food-plants of teak defoliators were discovered.

Insects of Sandal.

A few identifications of sandal insects were communicated during the year but several reports are still outstanding.

Insects of Bamboos.

The life-cycle of *Estigmena chinensis* (Chrysomelidae) in *Dendrocalamus strictus* was studied at Dehra Dun.

Beetles which become active at the onset of the monsoon die off by the middle of August. The maximum number of eggs laid by a female is twelve, deposited in batches of two to four on the surface of the internode under the free part of a culm sheath and covered with chewed up fragments of leaf so that they may be mistaken for pellets of excrement. Pupation begins at the end of August in the larval cavity. By the beginning of October about 80 per cent. of the pupae have transformed to beetles. The beetles remain in the cavities until the dry hot weather of April or May when the majority seek cooler shelter in the soil and soil covering. They quickly abandon bamboos felled during the cold weather and spring. The mortality in the beetle

stage is very high. The number of cavities is 4 to 7 times that of the beetles. Control appears to be attainable by maintenance of open uncongested clumps with a minimum of shade.

Cyrtotrachelus dux.—The life-cycle was studied in Lansdowne division, U. P., and at Dehra Dun. Beetles feed at the beginning of the rains on the new culms boring a pit with the long rostrum which is thrust in right up to its base. Feeding may be prolonged at one spot for several hours or even days, and, combined with the subsequent attack of scavengers, results in the death of the upper part of the culm. Eggs are deposited in similar pits located anywhere on internodes and hatch in a week to ten days. The larva bores inwards and works up the culm towards the top grooving the inner walls and perforating the nodes. On reaching the more solid top portion the larva hollows it out, eating the bud tissues and rapidly increasing in size. The length of the tunnel from the point of oviposition to the growing point depends on the rate of growth of the culm. The larval period is about a month and in August the dead top containing the mature larva falls to the ground. The larva buries itself about six inches deep in the soil, pupates and becomes a beetle in October, in which stage it hibernates and aestivates till the following monsoon season. The population of *C. dux* is not numerous but the potential damage due to each individual is high.

In cases of severe outbreaks collection and destruction of dead tops is the only direct remedy. Well thinned open clumps with a minimum of ground shade provide the most effective preventive measure.

The damage done by monkeys, pig, porcupines, and deer is as great as that due to insects.

Insects of Champ.

The insectary maintained at Samsing, Kalimpong, Bengal, was closed down in December 1934 after one year's work. The seasonal history of the champ bug, *Urostylis punctigera* (Pentatomidae) has been worked out. There are five generations in a year of which only the first and last are distinct. From the middle of March to November all stages of various broods are encountered. Hibernation occurs in the adult stage in a state of low activity. Adults may live throughout the colder season for six months in all but considerable mortality occurs in the hibernating population.

It has been demonstrated that the amount of injury caused by the feeding of *Urostylis* on young shoots of champ is dependent on the numbers of bugs present and the age of the plant. One year old plants may be killed by 30 to 40 nymphs in a fortnight; three year old plants are killed by ten times as many bugs in three weeks, and four to five year old trees succumb to the attack of 1,000 to 1,500 bugs in a month.

The extent to which a tree loses its foliage and dies back is thus very variable but fatal attack is less universal than was originally feared. Trees dying back in June to August put out new lateral shoots by September of the same year and those rendered leafless in September or October remain leafless throughout the cold and hot seasons and flush again in August. Trees in 10 to 16 year old plantations which were apparently killed have lost 5 to 15 feet of the stem, *i.e.*, to about 3 inches diameter, but have produced new leaders.

Gregarious flowering of champ is now known to occur in May; flowering trees are not centres for assembly.

Urostylis punctigera is controlled by heavy rainfall, a fungus disease, a chalcid egg parasite, and a coccinellid predator on the eggs and nymphs, and these factors coupled with falling temperatures reduce the population of the bug to base-level by the spring. It is not appreciably abundant during the period October-March.

Attacked champ trees sometimes develop a rot which is associated with a *Fusarium* and other fungi which are under investigation by the Mycologist.

Insects of Deodar.

From investigations made in Chakrata, United Provinces, it has been found that cutworms in deodar sowings belong to at least three species of Agrotinae but so far the cosmopolitan *Argotis ypsilon*, usually considered as the culprit, has not been reared. Their normal food in deodar forests is grass and weeds and the damage done to germinating deodar seedlings appears to be forced and not preferential. Cutworm damage can be prevented by keeping the nursery and beds which are to be sown, free from weeds from August onwards. If weeding is delayed until just before sowing a population of cutworms is left on the ground which will attack seedlings as soon as they germinate.

Cockchafers were investigated in Kulu, Punjab, and 47 species of cetonine, melolonthine and ruteline larvae were discovered in the soil of forests between 3,000, and 9,000 feet; of these 17 species actually occurred in seedbeds. The largest species of cockchafer grub is *Granida albosparsa;* other characteristic species are *Melolontha furcicauda* and *Mimela pectoralis*. Damage actually due to grubs in seedbeds begins in April and is most severe during May.

Nearly all the damage to the older seedlings in direct sowings and to transplants, which is usually ascribed to cockchafers, is actually due to other causes. Investigation shows that soil insects are of much less importance than other factors in causing the death of conifers between the ages of six and thirty months, and that the liability to damage is

not high enough or general enough to warrant special insect control measures. The remedy for mortality among transplants lies in improvement or proper application of cultural methods. Experiments are in progress on protective measures for nurseries.

Notes on cutworms and cockchafers are being published in the *Indian Forester.*

Insects of Gamari.

In connection with the fungus and/or virus diseases of *Gmelina arborea* the life history of a tingid infesting the foliage was studied. The nymphs of the first generation appear at the end of May and are adult by early July. A second generation extends from July to mid-August. The third generation develops from August to the end of September. It is believed that the adults of this generation lay eggs on the bark of twigs and in this stage the winter and hot weather is passed.

The nymphs and adults feed at the base of the blade of the leaf or in the axils, congregating mainly on the lower surface. The leaf becomes mottled and brownish patches form at the base over an area of 1½ to 2 inches. The leaves wither and fall and the shoots eventually die back. Further investigations are in progress.

Insects of Hollock, Mulberry, Oak, Shisham, etc.

The composition of the borer association of felled *hollock* was investigated in Sadiya division, Assam. Shothole and pinhole borers were comparatively scarce and the longicorn and weevil components of the association were diverse and varying in incidence. The evidence confirmed previous deductions that there was no single species (or a few species) breeding in predominant abundance in felled trees, that could be considered capable of killing standing healthy *hollock.*

The mulberry defoliator, *Glyphodes pyolalis* (Pyralidae) was bred throughout the year at Dehra Dun. It passes through six generations annually with hibernation as a larva.

Defoliation of *Quercus dilatata* in the western United Provinces by *Malacosoma indica* (Lasiocampidae) was reported but no field-work was undertaken during the year.

The seasonal history of the leaf-rolling weevil of shisham, *Apoderus sissu* (Curculionidae), was studied in the Insectary. There are eight generations in the course of the year with hibernation as a larva in the fallen leaf-roll in which pupation also occurs. The life-cycle from the time of deposition of the egg to maturation of the beetle is very brief, but the adults are long lived and feed and roll leaves for a considerable period.

Observations were made on the seasonal history of *Chrysocaspeda olearia* (Geometridae) a defoliator of *Eugenia jambolana*, which is found to have seven generations between mid August and early June of the following year and is presumed to have at least two more generations. Hibernation occurs as a larva.

A collector was sent to Ceylon in conjunction with the visit of the Silviculturist and considerable material in the form of borers, defoliators and soil insects was obtained which provides records of use in interpreting the ecology of forest insects in India.

Borers of Indian Timbers.

Material for the study of timber borers was collected on all tours and at the field-insectary in Kalimpong, Bengal. Other timbers felled at intervals during the cold weather are under study in Kurseong and Jalpaiguri divisions, Bengal. Several enquiries were received about the pests of logs intended for veneers, of made-up plywood, and of softwood planking, etc. A note was published in the *Indian Forester* on the biology and control of boxwood borers of the group *Heterobostrychus, Schistocerus* (Bostrychidae) showing that in mills and factories general disposal of infested waste and an annual clean up can provide effective protection.

The investigation of the seasonal incidence of marine borers in the estuary of the Beypore River, South Malabar, Madras was completed. The dominant species responsible for damage to logs stored in salt or brackish water is *Martesia fluminalis*. Teredo is of minor importance. A report was provided indicating the periods during which logs can be safely handled in water and the measures to be taken if water storage for the whole year is required.

Parasites and Predators.

Parasites of teak defoliators.—The list of parasites of *puera* and *machaeralis* has been materially increased and many of the new species have been described. The former has 25 species of parasites and the latter 45 species of which 4 are common to both. Newly recorded parasites are :—*Cedria anomala* (Braconidae) ; *Anomaloctenus melleus, Cremastus hapaliae, Cremastus* sp., *Mesostenus* sp., *Pristomerus microdon, Trophocampa indubia* (Ichneumonidae) ; *Eutachina civiloides* (Tachinidae), and new hyperparasites are :—*Hemiteles* sp., *Mesochorus indica, Microtoridea secunda* (Ichneumonidae). The life-histories of several species of Braconidae, Ichneumonidae and Tachinidae have been studied at Dehra Dun. An account of the biology of seventy species of Braconidae is in the press as an *Indian Forest Record ;* 13 of these parasitise *machaeralis* and six others *puera*.

Predators of teak defoliators.—Additional species of mantid predators have been found including *Ephestia intermedia, Dysaules himalayensis, Hetiasula brunneriana* and *Schizocephala* sp.; these have two generations a year. The life-histories of predaceous reduviid bugs *Acanthaspis* sp., and *Sycanus collaris* have been studied; the latter has two generations a year. Among the spiders being bred is one species that has lived for nearly three years hatching in June 1932, moulting 8 times, and ovipositing in June 1934.

The parasites and predators of all other species of forest insects reared at Dehra Dun have received attention. In the case of the hymenopterous parasites of species of *Dinoderus* (Bostrychidae) statistical data show that the adult population of parasites in a bamboo depot is about one-fifth of the adult population of borers, while the adult population of clerid and histerid predators amounts to less than one fiftieth of the adult borer population; but where conditions remain undisturbed the natural enemy population eventually outnumbers the borers.

General Insectary Work.

During the year 184 consignments of attacked material and insect specimens were received from various forest divisions in India for identification, etc. In the Insectary 149 cages were discontinued, and 550 were in progress. The total number of insects bred out was 24,371 of which 14,297 were set and labelled. Large quantities of material were in addition dealt within the laboratories.

A *Record* on the biology of the Psyllidae was sent to press. Thirty-four species attacking thirty-one forest trees were studied to determine the number and sequence of generations in this group. The gall formers include species with one and two generations per annum as well as some with eight. The forms living freely on leaves pass through as many as eleven generations.

Systematic Entomology.

During the year, 570 species, many of them new to science, have been added to the reference collection of identified insects. An outstanding feature is the friendly co-operation existing with numerous specialists in various parts of the world, which results in a rapidly increasing knowledge of the insect fauna of Indian forests out of all proportion to the actual size of this section. Acknowledgment is especially due to the Imperial Institute of Entomology for assistance in many ways, particularly for arranging the identification of the numerous parasites reared in association with biological investigations in past years. The Director, Sir G. A. K. Marshall, has himself given much of his valuable time to the identification of the great numbers of Cur-

culionidae whose names were urgently required in connection with studies being made at this Institute.

Numerous studies based on our material have appeared in *Indian Forest Records* and in other well-known scientific publications.

The Systematic Entomologist has continued to concentrate on the classification of the immature stages of the Coleoptera with special reference to xylophagous species. Several papers on the subject have been prepared for the press including one on the identification of larvae of the Scarabaeoidea, a group including many soil-inhabiting species which are pests of considerable importance in forest nurseries. There is now a large collection of larval dissections permanently mounted on microscopic slides in addition to a representative spirit collection.

Tours.—By Dr. Beeson to Simla in May; to Kulu, Punjab in May-June; to Ranchi in November and March (Lac Cess Committee); to Calcutta in November; to Delhi in February (Imperial Sericultural Committee). By Mr. Gardner to Chakrata, United Provinces in May-June. By Mr. N. C. Chatterjee to Kalimpong, Jalpaiguri and Kurseong, Bengal, in August-September. By Mr. S. N. Chatterjee to Puri, and Angul, Bihar and Orissa, Seoni, Jubbulpore and Saugor, Central Provinces in May-July. By Mr. B. M. Bhatia to Kulu, United Provinces in May-June; to Landsowne, United Provinces in August and October. By B. Gauri Dutt to Ceylon in November to January.

Museums.—The chief accessions to the entomological museum were 155 examples of damage to timbers by borers. In view of the renewal of educational courses at the Forest College the Zoological museum has received new exhibits.

Library.—143 books besides periodicals were added to the Zoological Library during the year.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

1. Research.

(*a*) Bulletin No. 84, entitled "Identification of the commercial timbers of the Punjab" was published during the year. Work in connection with the preparation of hand lens keys for Assam and Bengal was taken up. The object is to give in these bulletins up-to-date information regarding anatomical structure, with short notes on strength, seasoning properties, durability, working qualities, supply and uses of the commercial timbers of the provinces, with a view to make the publications as useful as possible to all interested in the timber-trade.

(*b*) Studies in the formation of growth rings in the woods of *Acacia catechu, Bombax malabaricum, Eugenia jambolana, Pinus longifolia, Shorea robusta, Tectona grandis* and *Terminalia tomentosa* were continued during the year. Wood blocks of *Acacia catechu, Pinus longifolia, Shorea robusta, Tectona grandis* and *Terminalia tomentosa* were cut and studied. During the coming year the remaining species will be critically studied.

Further observations were made on the initial distribution of parenchyma cells found in the *Terminalia tomentosa*. Results so far obtained have been very interesting and notes on this subject will be published shortly.

(*c*) Research on the anatomical study of the wood of Indian Dipterocarps was continued during the year. All the Indian species have been cut and mounted, and are now ready for critical study. Along with this study it has been thought advisable to make a general anatomical survey of the family *Dipterocarpaceae*. With this object in view authentic specimens of foreign Dipterocarps were obtained. These specimens will be carefully studied in due course.

(*d*) A preliminary investigation was carried out on the fluorescence in wood under ultra-violet light. For this purpose only a few Indian species were selected. The results obtained showed some possibility of their application for the purpose of identification and a short note was published in "Current Science", August 1934. A fuller account of the work is now in the press. This work was done in co-operation with the Chemistry Branch.

(*e*) The study of the different varieties of *Terminalia tomentosa* was continued during the year. It has been found that figured wood is not confined to any particular variety of laurel. The presence of figure in different varieties is erratic. Even in the same log figure may be found

in a few growth rings and may be entirely absent in the rest of the log. This investigation is not yet complete. In this connection it has been thought advisable to examine the various species of *Terminalia* in order to make this study as complete as possible.

(*f*) Study on the relationship between the anatomical structure and the physical properties of *Tectona grandis* (teak) from Burma was continued. The wood samples originally sent from Burma were found to be inadequate for this investigation. A tentative report based on the study of the ninty-one specimens has been sent to the Forest Economist, Burma, with suggestions for the selection of samples for future examination, if further investigation is desired.

(*g*) A study of the woods of the Indian *Meliaceae* (mahogany family) was continued. Up to date 34 wood specimens, from the collection of the Forest Research Institute, have been cut and mounted. More specimens will be cut and studied during the current year.

2. Identification of Woods.

As usual, a large number of timbers was received from various sources for identification. Among these the most interesting were 4 fossil woods sent by Mr. C. S. Purkayastha of the Assam Forest Service. The fossil No. 2 has been identified. It shows similarity in general features and in minute anatomy to living *Gluta* species of the *Anacardiaceae*. The name *Glutoxylon assamica* has, therefore, been proposed in a short note entitled "A fossil dicotyledonous wood from Assam", published in "Current Science", December 1934. A fuller account is under preparation and will be published soon.

The total number of timbers identified during the year was about 400.

3. Examination for Fungus.

Various enquirers sent samples of wood suspected of having been attacked by fungus. The number of specific enquiries replied to in this connection was 31.

4. Special Enquiries.

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for several business firms. In this connection 203 wood specimens were examined.

5. Indexing permanent slides and anatomical data.

In the course of routine work permanent slides were prepared from about 400 wood specimens. Whenever possible anatomical data have been collected from these slides and filed for future reference.

6. Collection of authentic wood specimens.

(*a*) *In India.*—Several authentic wood specimens were received for the standard collection.

(*b*) *From abroad.*—During the year altogether 367 wood specimens were received. Of these more than half were from Dr. H. P. Brown, Syracuse University, U. S. A. Other donors were Dr. L. Chalk, Imperial Forestry Institute, Oxford; Mr. B. J. Rendle, Forest Products Laboratory, England; Mr. H. E. Desch, Forest Research Institute, Malaya; Prof. S. J. Record, Yale University, U. S. A.; Directors, Field Museum of Natural History, Chicago; Forest Products Laboratory, Canada and the Chief of Forest Products, South Africa. Our sincere thanks are due to the above donors for helping the Forest Research Institute to make a complete collection of the commercial timbers of the world.

7. Distribution of Wood Specimens.

In response to requests from abroad and from various parts of India, 500 samples of timber were sent out to interested enquirers.

8. General.

A short course in Wood Technology was given to the following officer:—

Mr. Jayawardana, Assistant Conservator of Forests, Ceylon.

Over 20 photomicrographs were sent to various persons interested in wood identification.

9. Publications.

See Appendix I.

Timber Testing Section.

1. Staff.

Mr. L. N. Seaman held charge of the Section for the first eleven months. Mr. V. D. Limaye, Assistant in Charge, was sent on deputation to England and America by the Government of India in order to study Timber Testing methods in other countries. He visited the Laboratories at Princes Risborough, Paris, Ottawa, Madison, Vancouver, Manila, and Kuala Lumpur and saw logging operations in Vancouver, Federated Malaya States and in Burma. He also visited a number of lumber mills and wood working industries. After his return from deputation Mr. Limaye took officiating charge of the Section when Mr. Seaman proceeded on leave on the 6th of March and held charge till the end of the year.

2. Special Investigations.

(*a*) The study of the influence of friction on the results obtained with the standard shearing test tool was continued. The effect of the shape of the test specimen and the method of holding it in the tool is also being studied. The examination is not yet complete.

(*b*) *Cleistanthus collinus* and *Eucalyptus rostrata* poles were tested for suitability for use in electric transmission lines. Although mechanically they were strong enough the poles split badly while seasoning. Their utility depends on proper seasoning.

(*c*) *Fraxinus micrantha* from the United Provinces and mulberry from Changa Manga and Khanewal Plantations were tested for suitability for sports goods. Both of these were found to be as good as imported ash for this purpose.

(*d*) Tests were made in conjunction with the Seasoning Section to find the effect on strength of different treatments given to wood before seasoning. *Hopea parviflora, Anogeissus latifolia, Terminalia tomentosa, Xylia xylocarpa, Grewia tiliaefolia, Stereospermum xylocarpum* were tested. The investigation is still in progress.

(*e*) Different lots of sissoo (*Dalbergia sissoo*) from the Punjab, *viz.*, Changa Manga, Punjab Roadside, and River island sissoo, etc., were tested and compared for strength. A report on this will be issued in due course.

(*f*) Different lots of teak such as wide ringed teak, light and dark coloured teak, gum streaked teak, etc., were tested and compared for strength with normal teak. It was found that the quality of teak was reasonably good when the growth rate was anywhere between 4 and 20 rings per inch. It was also noticed that the colour had no significant effect upon strength.

(*g*) Wood used in aircraft construction and samples obtained from failures of aeroplanes were tested from time to time as required.

(*h*) 21 consignments of glue joints submitted by Ground Engineers of different Flying Clubs were examined and reported on to the Director of Civil Aviation in India.

(*i*) The Timber Sections of the Military Engineers' Handbook were re-written and a description of 45 species of wood together with working stresses and other tables were added.

(*j*) The Officer in Charge paid a visit to Rangoon to attend a Conference on the subject of Teak Grading. Data were obtained on more than 6,300 teak squares and from the analysis, grading rules were prepared in consultation with the lessees, the Burma Forest Department and the Timber Advisory Officer with the Railway Board. These grading rules are now being considered in detail by the teak lessees and the

Forest Economist, Burma. When the rules are finally approved and brought into force it will be possible to grade teak squares on the market in a more uniform manner and buyers will be able to select a definite grade according to requirements. These grades do not apply to converted material but to teak squares only as teak is generally sold in the form of squares which are converted by the buyers according to their own requirements.

3. Routine Testing.

During the year under report good progress was made on the routine testing programme although it was somewhat delayed by the necessity for making special tests and by the teak grading work. Work under Project 1 (Standard Tests on Small Clear Specimens) and Project 2 (Standard Tests on Structural Timbers) was continued. Other routine testing such as glues, plywood, containers, etc., was also done in co-operation with the Wood Workshop Section.

No. of species tested during the year.

	Green.	Air Dry.	Kiln Dry.	
Project 1 . . .	9	7	6	
Project 2 . . .	..	4	..	
Project 0 under various subheads . .	..	..	..	73 consignments.

The testing also includes 21 consignments of glue joints submitted by Ground Engineers for examination.

No. of species computed during the year.

	Green.	Air Dry.	Kiln Dry.	
Project 1 . . .	8	6	6	
Project 2 . . .	1	2	..	
Project 0 . . .	..	..	..	69 consignments.

Over 14,000 Mechanical tests and nearly the same number of Physical determinations were made during the year. 4,000 special shrinkage observations were also made in addition to routine computations. Reports on 6,300 teak squares consisting of about 187,000 cubic feet of timber were analysed and numerous tables were prepared involving much computing work for the study of teak grading.

4. Technical notes and advice.

125 technical notes and letters were issued during the year, among which the following may be mentioned :—

1. Comparison of different lots of teak.
2. Comparison of different lots of sissoo.
3. Specifications for Railway Sleepers.
4. Wood suitable for flooring.
5. Indigenous substitutes for walnut for making gun stocks.
6. Wood for cooling towers.
7. Wood suitable for bridge work.
8. Wood for various kinds of handles such as hammer handles, phowrah handles, etc.
9. Wood for sports goods.
10. Wood for transmission poles.
11. Wood for yacht masts.
12. Suitability of wood for Railway floor boards.
13. Wood for cotton reels, shuttles, etc.
14. Indigenous substitutes for polo stick heads.
15. Indigenous substitutes for hickory, ash, birch, maple, and willow.
16. Wood for motor bodies.
17. Species suitable for deck planking.

5. Publications.

See Appendix I.

Wood Seasoning Section.

1. New Method of Kiln Drying.

Considerable progress was made with the new method of kiln drying developed at this Institute. During the year, 29 charges of timber covering 16 species were dried in the two small internal fan kilns, and except in the case of 2 species, namely *Shorea robusta* and *Schima wallichii*, the results obtained were quite satisfactory. Owing to insufficient supplies of suitable timbers, only 4 kiln charges were undertaken in the large kilns, and results in all the cases were highly successful. One inch thick planks of *Cedrela toona* were dried from about 95 per cent. to 10 per cent. moisture content in 8 days. The timber was

of very poor quality, from road-side trees of irregular growth, having numerous decayed knots, occluded bark and cross grain. In spite of this, the increase in degrade was negligible, being confined to some collapse around decayed knots, and some warping and twisting of wide tangential planks. A charge of *Amoora wallichii*, one inch planks, was dried from about 70 per cent. to 9 per cent. moisture content, taking 9 days in all, and the condition of the timber at the end of drying was excellent. The final tests indicated an almost entire absence of drying stresses, and a very uniform moisture distribution in the wood. A mixed charge of *Dipterocarpus turbinatus*, *Dichopsis elliptica*, *Hardwickia pinnata*, and *Hopea parviflora* was very successfully dried. *Dipterocarpus turbinatus* (gurjun) contained as much as 120 per cent. moisture, the planks being up to 28 inches wide. At the end of 20 days, the average moisture content for the whole lot was 10 per cent. and even the widest gurjun planks did not have more than 11·6 per cent. moisture. The results obtained in all these cases are a considerable improvement on the old process of drying, giving a better quality of dried material at a lower cost.

A note on the kiln drying of laurel (*Terminalia tomentosa*) according to the new process of kiln drying was published in the August 1934 issue of the *Indian Forester*, which evoked a number of enquiries from India and abroad. Another short note on the new method of drying has been published in the March 1935 issue of the *Hardwood Record* of Chicago, U. S. A. A detailed analysis of the results so far obtained with this method will be published shortly as a Forest Bulletin.

It is gratifying to note that there is an increase in the number of enquiries about the design of timber seasoning kilns. Drawings and specifications were supplied to a number of enquirers, and out of these 3 firms in Assam, Bengal and Madras have decided to put up kiln drying installations during the coming year.

2. Furnace Kiln.

At the close of the year, the erection of the furnace and of the accessory plant was completed and one charge of white dhup, *Canarium euphyllum*, 1 inch thick planks was successfully dried from the green condition to about 10 per cent. moisture content. Except for a slight discoloration of the wood due to unburnt smoke, which was entirely removed by planing, there was no degrade whatsoever.

The chief advantage of this kiln is that it is independent of a steam boiler and can be worked entirely on wood refuse and sawmill waste. Some kind of motive power is, however, required for working the centrifugal fan, which delivers the hot gases from the furnace to the kiln. Temperature can be controlled by regulation of fresh air to the generator

and the humidity by means of water sprays. Further tests with this kiln will be carried out during the coming year and a detailed report will be issued.

3. Kiln Drying with Ozone.

Experiments were completed last year and it was found that addition of ozone to the air circulating in a kiln did not have any effect on the rate of drying or on the shrinkage of any of the four species tested. A detailed report has been issued as Indian Forest Records, Vol. XX, Part XIII, "Results of Experiments on the Kiln Drying of Wood with Ozonized Air".

4. Drying under Vacuum.

No further experiments could be carried out during this year. It is, however, interesting to note that an oak sleeper was sent to this Institute by a Swedish firm, which they stated had been dried under vacuum to a moisture content of 12 per cent. in 35 hours. On testing it was found that the sleeper contained on an average 27 per cent. moisture, with a gradient of 13 per cent. in the surface layers to 45 per cent. in the interior. The weight of the sleeper during transit came down from 80 Kg. to 64 Kg., which would give an initial moisture content of about 60 per cent. at the time the sleeper was despatched. It is not unusual to find claims of this nature made which are not verified after careful examination in the Institute.

5. Air Seasoning.

Final observations were taken on all the air seasoning experiments that were in progress at the beginning of the year, and the results were incorporated in the "Manual on Air Seasoning of Indian Timbers", published during the year.

Further studies on the air-seasoning of some of the highly refractory species were undertaken, which included the following among others :—

(i) *Eugenia gardneri.*

(ii) *Hopea parviflora.*

(iii) *Quercus lamellosa.*

(iv) *Quercus lineata.*

(v) *Schima wallichii.*

In order to slow down the rate of seasoning, the timber was stacked with very thin crossers, and even without crossers at all. Results with *Hopea parviflora* and *Quercus lamellosa* appear to be promising so far, in stacks without any crossers.

6. Water soaking prior to air-seasoning.

An experiment on the water soaking of the following timbers for periods varying from 1 to 5 years was started during the year :—

(i) *Amoora wallichii.*

(ii) *Anogeissus latifolia.*

(iii) *Eugenia gardneri.*

(iv) *Hopea parviflora.*

(v) *Quercus lamellosa.*

(vi) *Quercus lineata.*

Matched material of the following species, air seasoned with and without previous water immersion, was sent to the Timber Testing Section, for determining the strength under impact, in order to find out whether water soaking has any adverse effect on this property :—

(i) *Anogeissus latifolia.*

(ii) *Eugenia gardneri.*

(iii) *Grewia tiliaefolia.*

(iv) *Hopea parviflora.*

(v) *Stereospermum xylocarpum.*

(vi) *Xylia xylocarpa.*

7. Air Seasoning of Railway Sleepers.

The experiment on the air seasoning of Railway sleepers, started at Dhilwan during the previous year, in co-operation with the North Western Railway and the Punjab Forest Department, was continued till the middle of November 1934, when the final observations were taken. During the dry summer months, March to June, one-third of the number of sleepers was stacked in the " 1 and 9 " method and the rest in close crib stacks. In the first week of July, all the sleepers were inspected for development of defects and moisture loss, and were passed by a Railway Sleeper Passing Officer. The sleepers were then re-stacked in the " 1 and 9 " method, as, during the monsoon, the close crib stacking was considered to be hazardous, on account of the liability to decay and fungus attack. The final inspection and passing were carried out in the middle of November 1934. A preliminary report on the results obtained in this experiment was published in the *Indian Forester* of July 1934, and the final report will shortly be issued as a Forest Bulletin. From the data obtained in the experiment, the following general conclusions can be drawn, which are substantially the same as those reported last year.

1. *End-tarring.*—The ends of all the sleepers should be given a thick coating of coal-tar or of some other suitable material as soon as possible after the sleepers are taken out of the water.

2. *Stacking.*—Deodar and fir sleepers can be stacked either in the " 1 and 9 " or in the close crib manner, from the beginning to the end of dry weather, provided the ends of sleepers are well protected against too rapid drying. Chir sleepers should be stacked in the " 1 and 9 " method, on account of their liability to decay and fungus attack.

3. *Seasoning period.*—Softwood sleepers after their arrival at depots in the plains require about a year for complete seasoning. In the case of deodar sleepers, which may be used in the line without antiseptic treatment, it is necessary that seasoning should be carried out for this period under controlled conditions.

Another experiment on the seasoning of sleepers was carried out at Marala in co-operation with Messrs. Spedding, Dinga Singh & Co. Two thousand deodar sleepers were stacked at the end of April 1934, in order to find out the effect of end-tarring and to compare the " 1 and 9 " and the close crib methods. The experiment had to be discontinued in the 2nd week of July 1934 and the results were disappointing. At the end of two months, the percentage of rejections due to seasoning defects amounted to 17 per cent. and there was no significant difference between the sleepers stacked in the " 1 and 9 " and the close crib manner. End-tarring was also ineffective in preventing the end cracking of sleepers. The only conclusion that can be drawn from this experiment is that it is difficult to find any practical method, other than the erection of costly air seasoning sheds, which would prevent heavy damage during seasoning, if the sleepers arrive during the dry weather.

In this connection the Officer in Charge paid a visit to some timber exploitation works in the Kulu forests in September 1934, in order to study the method of conversion and extraction of sleepers. As a result of this tour a number of suggestions were offered for the consideration of the Punjab Forest Department, and during the following year it has been decided to carry out an experiment in the Upper Bashahr Division to determine the effect of seasoning sleepers in the forests for various periods before launching.

8. Laboratory Experiments.

1. *Methods of moisture determination.*—The work on this item was completed last year and a paper was written up, which will be published in the *Empire Forestry Journal.*

Some preliminary experiments were carried out on testing the accuracy of the Tag-Heppenstall and the " Blinker " moisture meters

and a detailed note on the methods of rapid determination of moisture content of wood has been sent to the *Indian Forester* for publication.

2. *Shrinkage and Hygroscopicity Experiments.*—Work on the seven species taken up during the last two years was completed and a detailed study of the following species was taken in hand during the year :—

1. *Tectona grandis*, teak, ungirdled from Burma.
2. *Tectona grandis*, teak, girdled from Burma.
3. *Dalbergia sissoo*, sissoo.
4. *Cedrela toona*, toon.
5. *Eucalyptus eugenioides.*

Various experiments have been carried out during the year to determine the effect on shrinkage, swelling and hygroscopicity of woods after the following treatments.

1. Impregnation with various chemicals.
2. Boiling in water.
3. Steaming at various pressures for different periods.
4. Exposing wood to high temperature and low humidity for long periods.
5. Metal spraying of wood.
6. Kiln drying under varying conditions of temperature and humidity.

The results of these experiments are being worked up and will be published during the coming year.

9. Enquiries.

A large number of enquiries on various subjects relating to the air and kiln drying of timbers was replied to as usual. As mentioned before, kiln drying is receiving increasing attention in the country, as can be judged from the number of enquirers who want information on the design and erection of kilns.

10. Publications.

See Appendix I.

Wood Preservation Section.

Mr. S. Kamesam held charge of the Section throughout the year except for a period of one month when his services were lent on deputation to the Travancore State.

1. The Raman Committee Report on Ascu wood preservative.

Reference was made in last year's report to an investigation of the Ascu wood preservative by a special committee appointed by the Railway Board. The committee re-assembled in Simla in June 1934. After a three days' session, the committee signed a unanimous report on the Ascu wood preservative. The report has been published under the title of " Report of the Committee appointed by the Railway Board to report on the Suitability of the Falkamesam Preservative for treating timber ".

The Committee agreed that Ascu could be considered " to be an improvement on the present method of treating sleepers and expected to show a saving in cost ". They required assurance that Ascu treated sleepers would not be liable to split any more than those treated at present with the oil creosote process.

The Committee recommended that 25,000 sleepers each of deodar, chir, fir, kail, hollock and hollong should be treated with Ascu under pressure, and also with a special anti-splitting medium consisting of a bituminous suspension. This recommendation was accepted by the Railway Board. It is obvious from the report that as far as the efficacy of Ascu as a wood preservative was concerned, the Committee was satisfied. The Committee considered that periodical observations and reports on these Ascu treated sleepers compared with others of the same species in the same locality treated by the ordinary oil creosote process during the next two or three years " should be capable of furnishing material for a final decision as between the Ascu preservative and the existing method of treatment ".

2. Large scale field experiments by the Indian Railways.

After the publication of the Raman Committee Report in July 1934 the Director of Civil Engineering, Railway Board, accompanied by the Secretary of the Raman Committee visited the Wood Preservation Section when details regarding the preliminary experiments that were to be made for carrying out the recommendations of the Raman Committee were discussed. A definite programme of work was drawn up for deriving the proper specifications for the treatment (of the lakh and a half of experimental sleepers) with Ascu and with a bituminous suspension.

The preliminary tests were concluded about the end of November 1934 when a detailed report on the results obtained was prepared, along with definite recommendations based on them, and presented to the Railway Board. The Director of Civil Engineering accompanied by the Joint Timber Advisory Officer to the Railway Board and the Army

Departments again visited the Wood Preservation Section in the third week of December 1934 to inspect the sleepers treated in the preliminary tests and to discuss the procedure for carrying out the large scale test.

The recommendations made regarding the Ascu and anti-splitting treatments of the six species concerned were accepted by the Railway Board. In March, 1935, it was decided that about 14,400 B. G. coniferous sleepers should be treated at an early date with Ascu and the anti-splitting medium. This comparatively small number was chosen for the first year by representatives of the Railway Board, the Forest Research Institute and the North Western Railway in order to dislocate to a minimum the sleeper renewal programme of the North Western Railway during 1935-36, and also to see whether there would be any unforeseen difficulties encountered in the actual treatment of a large number of sleepers with Ascu. It is confidently expected that a very much larger number will be treated next year.

3. Specifications for the Ascu and anti-splitting treatment of the six species.

Chir, fir, deodar and blue-pine will be treated by the Rueping process with two concentrations of Ascu solution, *viz.*, 8 per cent. and 4 per cent. hollock will be treated by the Lowry process with the same concentrations. The first three species will be treated with an initial air pressure of 50 lbs. sq. in. whereas with blue-pine the pressure will be 75 lbs. sq. in. In the case of hollong sleepers, the Lowry process will be employed using two concentrations of the preservative, *viz.*,4 per cent. and 2 per cent. The anti-splitting treatment in the case of chir, blue-pine and hollong will consist of 5 minutes' immersion in a hot 10 per cent. asphaltic suspension in crude oil. In the case of hollock and incised silver fir the period of immersion will be 10 minutes, whereas with deodar, the period will be 15 minutes. One half of the Ascu treated sleepers for each of the two concentrations will be treated by the above specification against splitting. The other half in each case will be treated with precisely the same bituminous composition but the period of immersion will be double that in the previous case.

4. Practical application of the Ascu wood preservative.

(i) During the year the Government of the United Provinces, represented by the Irrigation Department, accepted the use of Ascu for preserving sapwood timber poles for the transmission of electricity at 11 K. V. in the Meerut grid area. It is expected that within the next year, a few hundred miles of such rural distribution lines will be installed.

(ii) The Officer in Charge of the Section examined the timber resources of Travancore and made several recommendations to the Government for the exploitation of the State's timber resources, preferably after treatment with Ascu. Practically all the recommendations, including the Ascu wood preservative, on which the recommendations are based, have since been accepted by the Government. The most important of these is the immediate use of Ascu treated timber poles in connection with the Pallivasal Hydro-electric scheme. A plant is being installed by the Travancore Government for operating the Ascu process to treat several thousand poles both for electrical transmission, distribution and telephone construction.

(iii) The Government of Mysore has officially accepted the Ascu preservative. They are treating over 20,000 c. ft. of timber in the form of poles and sleepers during the current year with Ascu.

(iv) The Government of Bhopal have also accepted the Ascu wood preservative, and Mr. Kamesam will be shortly deputed to the Bhopal State for doing work similar to that done for Mysore and Travancore.

(v) The Government of Madras have brought into operation two pressure plants employing Ascu as the wood preservative. They are under the supervision of the Director of Agriculture and the Director of Fisheries.

(vi) The first private commercial wood preservation plant in India was ready by March, 1935. It was put up by the Ascu Wood Preserving Agency, Dehra Dun, who are the sole licensees of the Ascu patent in India. It is understood that during the next few months they will have three or four pressure plants operating in Northern India. The Agency has been commissioned to preserve with Ascu a thousand 36 feet long blue pine poles for the electrification of a well-known Punjab hill station, besides four thousand poles for the United Provinces Government. It is understood that the Agency will shortly put up two more Ascu plants.

5. Further results of veneer and bamboo tests.

Some important results obtained by employing veneer test pieces treated with different wood preservatives were mentioned in last year's report. The Raman Committee report contains much data of value obtained by this technique. Ascu treated bamboos have given very satisfactory results, being intact after 15 months in a very severely white-ant and fungus infested area in which the untreated controls perished in a short time.

6. Fire-proofing treatment with Ascu.

Preliminary experiments to evolve a one movement fire-proofing and Ascu treatment were made, with fair degree of success, about the

close of the year; it appears that the incorporation with Ascu of ammonium sulphate, which is one of the cheapest fire-proofing chemicals known, provides an efficient combined fire-proofing, termite and rot proofing treatment. Experiments are in progress to perfect the process so that it can be used in commercial plants.

7. ANTI-SPLITTING TREATMENT OF TIMBER WITH BITUMINOUS EMULSIONS.

Recent experimental results as well as patent literature on the subject show that petroleum asphalt is one of the most efficient and economical anti-splitting media known. Instead of employing the asphalt as a suspension in crude oil, it is proposed to employ it after emulsification with water. The crude oil as a medium to spread asphalt on timber is expensive compared with water as an emulsifier. Preliminary experiments in this direction were made with success at the close of the year. The two chief advantages of the bituminous emulsion over a suspension in crude oil are, firstly, no heat will be required in the field for the application of the asphaltic anti-splitting treatment, and secondly, the treatment, for the same asphaltic content, may be expected to be about 25 per cent. cheaper than an asphaltic suspension in crude oil.

8. PROJECT IV AND GRAVE YARD TESTS.

198 B. G. sleepers of *Parashorea stellata* from Burma were treated and handed over to the East Indian Railway for durability trials.

During the year the following were added to the timber test yard of the Section ;—

(i) Treetex.

(ii) Insulation Board.

(iii) Paralac 148.

(iv) Ascu treated and untreated sapwood posts of chir and teak with and without water-proofing butt treatments.

(v) A dozen sticks of each of the six species of timbers (chir, fir, deodar, kail, hollock and hollong) treated with different concentrations of Ascu along with control specimens treated with 40 per cent. creosote and 60 per cent. earth oil.

(vi) Cross-Sections from Ascu treated sleepers.

(vii) Specimens treated with Cuprinol.

Untreated specimens of the three following species of timber were also added during the year :—

(i) *Butea frondosa.*

(ii) *Phoebe* spp.

(iii) *Eucalyptus* spp.

9. Marine tests.

Ascu treated chir sapling posts along with untreated controls were sent to the harbours of Calcutta, Vizagapatam, Madras, Bombay and Karachi for exposure to marine organisms.

10. Tours.

The Officer in Charge inspected experimental sleepers installed in the Bengal Nagpur Railway, Madras and Southern Mahratta Railway, and marine specimens in the Calcutta, Vizagapatam and Madras harbours. After exposure to marine organisms for 18 months the Falkamesam and Ascu treated specimens were observed to be absolutely intact while the untreated controls were either entirely destroyed or badly attacked.

11. Publications.

Forest Bulletin No. 85 entitled " A Record of the Results obtained with Experimental Treated Sleepers laid in the Indian Railways between 1911 and 1916 " came out of the press during the year.

Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other Sections, while the Officer in Charge devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 14,328 wood specimens for test purposes.

The Wood Technology Section was supplied with 41 Gamble and 713 hand specimens and 14 cubes for specific gravity tests.

563 orders of maintenance and routine work were completed during the year.

221 logs of the following species were converted in the Saw-mill :—

Alnus nepalensis for strength tests.

Anthocephalus cadamba for strength tests.

Fraxinus macrantha for strength tests.

Morus alba for strength tests.

Butea frondosa for strength tests.

Phoebe spp. for strength tests.

Dalbergia sissoo for strength tests.

Cryptomeria japonica for strength tests.

Eucalyptus euginoides for strength tests.

Tectona grandis for strength tests.

Shorea robusta for strength tests.

Terminalia tomentosa for seasoning tests.

Cedrela toona for seasoning tests.

Anogeissus latifolia for seasoning tests.

Amoora wallichii for seasoning tests.

Terminalia paniculata for seasoning tests.

Quercus lineata for seasoning tests.

Quercus lamellosa for seasoning tests.

Hopea parviflora for seasoning tests.

Eugenia gardneri for seasoning tests.

Dichopsis elliptica for seasoning tests.

Hardwickia pinnata for seasoning tests.

Schima wallichii for seasoning tests.

Terminalia bialata for seasoning tests.

Canarium euphyllum for seasoning tests.

Dipterocarpus alatus for veneer tests.

Lophopetalum wightianum for veneer tests.

Dipterocarpus turbinatus for veneer tests.

Dipterocarpus tuberculatus for veneer tests.

Pinus longifolia for General use in Wood Workshop Section.

Anisoptera glabra for General use in Wood Workshop Section.

Mangifera indica for General use in Wood Workshop Section.

Abies pindrow for General use in Wood Workshop Section.

In addition to the above, 246 paving blocks were prepared from old sleepers for the Wood Preservation Section, 12 sleepers were converted into shingles, 25 sleepers into scantlings, 2 pieces sleepers into planks for the Wood Preservation Section, 350 bullies cut into halves for the President, Forest Research Institute, branches of *Mangifera indica* converted for making charcoal for the Minor Forest Products Section.

Reports on the working qualities of the undermentioned timbers were issued during the period under review :—

Dalbergia latifolia (rosewood).

Lagerstroemia lanceolata (benteak).

Mallotus philippinensis (roini).

Miliusa velutina (domsal).

Alnus nepalensis (Indian alder) kiln dried.

Dalbergia sissoo (Punjab roadside sissoo).

Cryptomeria japonica (dhupi).

Phoebe spp. (mekahi).

Butea frondosa (dhak).

Anthocephalus cadamba (kadam).

Alnus nepalensis (Indian alder) air dried.

A large number of enquiries were received from various sources and were replied to.

Veneer Sub-Section.—The Veneer Sub-Section was closed down up to 2nd November 1934 owing to the absence of the Officer in Charge on long leave.

Logs of the following species were peeled for tests under Project VIII on return of the Officer in Charge :—

Terminalia tomentosa (Burma).

Dipterocarpus alatus (Burma).

Tamarix articulata (Punjab).

Machilus macrantha (Mysore).

Cryptomeria japonica (Bengal).

Dipterocarpus turbinatus (Burma).

Lophopetalum wightianum (Madras).

Tests.

Tests on glues were carried out as follows and results submitted to :—

1. Messrs. The Swastika Chemical Co., Saharanpur, United Provinces, on a sample of Casein.
2. The Director of Civil Aviation in India, New Delhi, on glue joints to find out deterioration by fungal growth.
3. The Assistant Aircraft Inspector, Dum Dum, Calcutta, on a sample of glue.

Tests were also carried out on various fillers for open joints on parquet floor, glue and saw dust, glue and chalk, plastic wood, and plastic wood and chalk. Glue and saw dust appeared to be the cheapest and best.

Numerous enquiries relating to veneers, plywood and glues were received during the year and dealt with.

Reports.

An Interim Report on the work done up to the end of 1933 under Project VIII (Testing of Veneers and Plywood) has been published. This

Interim Report has been reviewed favourably by the Press and experts both in India and abroad and there now appears every hope of the plywood industry materializing in India.

Minor Forest Products Section.

1. General.

The Forest Economist is nominally in charge of this Section, and the total staff of the Section consists of one Upper Grade Assistant (Mr. Ramaswami), one laboratory assistant and a few coolies. With such a staff very little research work can be accomplished.

2. F. R. I. Portable Charcoal Kiln (" Frikiln ").

A note embodying the details of the working of the " Frikiln " was published in the " Indian Forester " (January 1935). Numerous enquiries have been received from forest officers and charcoal contractors for information about this kiln. According to the current prices of materials and labour it has been estimated that the " Frikiln " could not be made for less than Rs. 443 each. As this figure is still considered to be too high, experiments are being made to do away with unnecessary parts without sacrificing the efficiency of the kiln; some success has been attained in this direction in making charcoal in the kiln without using the air-admission apparatus, entry of air into the kiln being controlled through small holes made in the earth at the base of each lower panel; at the end of a burn these holes are closed by banking them up with earth.

3. Charcoal Briquetting.

A charcoal grinding machine (a second hand *soorki* mill) was erected during the year. About 100 lbs. of charcoal is ground and mixed with the binders at each charge, prior to briquetting in the rotary press. As the result of these large scale experiments, the following results have been obtained :—

1. Good briquettes can be made using 5 per cent. of *Bauhinia retusa* gum and 4 per cent. of rice flour (boiled in 30-40 per cent. of water). This confirms the results of the previous small scale experiments. These briquettes burn well and do not break easily.
2. The cost of manufacturing briquettes by the above method works out at about 8 annas per maund of 80 lbs.
3. Briquettes are wet when freshly made and in small scale experiments these were spread out in a thin layer on a cement

floor for drying. When several tons of briquettes are made in a day, special drying chambers will be necessary and this will naturally increase the cost of briquetting.

4. The search for a cheaper binder becomes a necessity to compensate for the cost of drying. Experiments in this direction will be conducted in the following year.

4. Minor Forest Products Garden—Cultivation of medicinal plants.

As mentioned in last year's annual report, a list of medicinal plants suitable for cultivation in the Minor Forest Products Garden was prepared and approved by Lt.-Col. Chopra, Professor of Pharmacology, in the School of Tropical Medicine, Calcutta; out of this a start was made with about a dozen plants.

As mentioned in the previous report, experiments on the propagation of *Artemisia maritima* by stem cuttings as well as by root and shoot cuttings were continued during the year. The cuttings planted during the previous year survived the monsoon without casualties and produced seeds during the winter, whereas numerous seedlings put out as control in the same bed have died. Cuttings are best planted in March in Dehra Dun ; in the plains it may have to be done a month earlier.

Cuttings of *Derris elliptica* and *Derris malaccensis,* from the roots of of which the insecticide rotenone is prepared, were obtained from Malaya and planted in the Garden Nursery. Only 4 per cent. of the former and 28 per cent. of the latter have survived. The heavy mortality was possibly due to the unusually severe winter.

Chrysanthemum cinerariaefolium (pyrethrum) started flowering at the close of the year (end of March). Regeneration by off-shoots made before the plants flowered was tried and found to be successful.

Psyllium sown in October-November 1933 gave a good yield of seeds and its cultivation was continued during the year in larger beds. The plants were flowering at the close of the year.

5. Match Woods.

A note on Indian Timbers tested for match manufacture was prepared. Tests carried out in this Institute as well as by various match factories in India have been incorporated in the note.

6. Collection of information on the drugs of forest importance.

This work was carried out in conjunction with the Bio-chemist and the Forest Botanist, and the actual collection of information was finished at the close of the year and the work of arranging it has been taken up.

7. Enquiries.

During the year over 250 enquiries from Forest officers, contractors, exporters and others from India and abroad, dealing with the supply, collection, marketing, prices, etc., of various minor forest products of India were answered.

Paper Pulp Section.

1. Experimental Factory.

(*a*) *Disintegration of bamboos.*—Experiments on the disintegration of bamboos in the Norris and Christy machine were continued in the year under report. In order to obtain satisfactory chips, it was found necessary to have on the machine a suitable automatic feeding arrangement for bamboos. This has been designed and is being made by the Mechanical Engineer of the Institute.

(*b*) *Dendrocalamus hamiltonii* (*kokwa*) and *Oxytenanthera auriculata* (kaliserri) bamboos.—Semi-commercial tests on these bamboos were completed. Sulphate process was employed for the digestion of the bamboos. Both the species were found suitable for the manufacture of a variety of papers. Tests on mixed species of bamboos will be taken up next year.

(*c*) *Pulp for artificial silk.*—Experiments on the production of specially purified pulp for artificial silk production from *Ochlandra brandisii* (eta) and *Melocanna bambusoides* (*muli*) bamboos were carried out throughout the year. Although alpha cellulose content and copper number of the pulps obtained were satisfactory, the viscosity was low in each case. Experiments have to be continued in order to obtain pulp with the requisite characteristics.

(*d*) *Anthistiria gigantea* (ulla grass).—Experiments were carried out on *Anthistiria gigantea* (ulla grass). By adopting a modified overhead sulphate method of digestion it was possible to obtain about 40 per cent. yield of clean bleached pulp, with an economic consumption of chemicals for digestion and bleaching. Very satisfactory qualities of *badami* and white papers were made from the grass pulp by itself and in admixture with small proportions of bamboo pulp. The grass, therefore, appears to be a satisfactory raw material for paper making, and should be useful to supplement the supplies of *sabai* grass in the United Provinces.

(*e*) *Sabai grass.*—Antique papers and imitation art paper were made from *Ischoemum angustifolium* (*sabai* grass) supplied from the Saharanpur Forest Division.

(*f*) *Pinus longifolia* (chir).—Experiments by the sulphate process were carried out on *Pinus longifolia* (*chir*) thinnings from the New Forest

Plantation Area. Although fairly clean unbleached and bleached pulps were obtained, the percentage yields of cellulose were low and the consumption of chemicals correspondingly high. It is proposed to carry out further tests on material obtained from the Almora Division.

(*g*) *Bagasse.*—Experiments were carried out on bagasse (crushed sugar cane) for the production of *badami* and packing papers in admixture with small proportions of bamboo pulp. Fairly satisfactory results were obtained. The use of bagasse for paper making, however, does not appear to be a feasible proposition except in a very few places. It is usually burnt as fuel in sugar factories and in most places the cost of coal or wood fuel makes the corresponding cost of bagasse uneconomic for paper making purposes.

(*h*) *Flax waste.*—The Director of Industries, United Provinces, it is reported, has succeeded in developing a method for separating to a large extent the woody cores from the short fibres. The latter will, therefore, yield a much cleaner pulp without requiring any intermediate grinding of the pulp. Thin white paper, suitable for type-writing purposes, was made from pulp prepared at the Institute from the material.

(*i*) *Manufacture of paper.*—About 3½ tons of writing, printing, type and kraft papers, and mounting and drying boards were manufactured in the factory, of which about 2 tons were supplied to the Manager, Government of India Press and the various offices of the Forest Research Institute and College.

2. Laboratory.

(*a*) *Pulp for artificial silk.*—Determination of alpha cellulose, ash, copper number and cuprammonium viscosity were carried out in connection with samples of purified pulp prepared, both in the factory and the laboratory.

(*b*) *Chemical analyses of raw materials.*—Determinations of cellulose, lignin, pentosans, ash, caustic soda solubility, etc., were made in—

(1) *Dendrocalamus strictus*,

(2) *Bambusa arundinacea*,

(3) *Dendrocalamus hamiltonii*,

(4) *Oxytenanthera auriculata*, and

(5) *Oxytenanthera nigrociliata*.

(*c*) *Autoclave tests.*—These were carried out on *chir* from the Dehra Dun Area and on bagasse.

(*d*) *Nettle fibres.*—Experiments were carried out on the production of papers for currency notes from the material supplied by a private concern.

(*e*) *Bagasse and whole linseed straw.*—Samples of boards were prepared from these materials for the Sugar Technologist and the Director of Industries, United Provinces.

(*f*) *Boiler feed water.*—Routine analytical tests in connection with the softening of the boiler feed water were carried out, as and when required.

3. Tours and enquiries.

(*a*) The Officer-in-Charge, in January 1935, visited the Paper Mills at Kankinara, Naihati and Raniganj, where modern and improved bamboo pulping plants have been put up in recent years. The three mills are now using about 30,000 tons of bamboos per annum and expect considerably to increase the consumption in the near future, as soon as certain initial difficulties have been overcome and the necessary extensions to the plants have been made.

(*b*) Correspondence was carried on with private individuals, commercial firms and Government departments in connection with various technical enquiries referred to the Section.

4. Paper Mills' Conference.

With a view to effect closer co-operation between the Paper Industry and the Paper Pulp Section at the Institute, the President, Forest Research Institute and College, convened a Conference in Calcutta on the 13th and 14th March 1935, at which representatives of all the Paper Mills, operating in this country, attended. The Conference was highly successful and as a result, a scheme of co-operative research work, on problems of direct and immediate interest to the Industry, was laid down. It is hoped that the services of the Paper Pulp Section, working in close co-operation with the Industry, will be of greater utility for the scientific and continued growth of the Pulp and Paper Industry in this country.

MECHANICAL SUB-SECTION.

This auxiliary Sub-Section functioned most satisfactorily throughout the year under the guidance of Mr. Ram Das Tandan, the Mechanical Engineer and B. B. L. Saksena, his Electrical Assistant.

In addition to a large number of daily routine jobs and other petty jobs which cannot be booked in the work order register, there were 500 jobs in all which were completed during the year. The electric installation in the workshops of the Economic Branch, railway trucks and track, lorries, fire appliance, boilers and their attachments, steam pipes and fittings, and plant attached to all Sections of the Economic Branch were all maintained in good order.

A new Furnace Kiln was erected for the Seasoning Section.

Necessary changes were made in the disintegrater in the Paper Pulp Section to improve the grinding of bamboo to the desired quality.

Necessary materials were made for preparing 4 timber-concrete beams and the beams were completed to the desired specification for Timber Testing Section.

A new body was designed and made with the help of the Foreman of the Wood Workshops for the new Chevrolet Bus.

The vacuum cylinder in the Seasoning Section was fitted with a fan, workable by a motor fitted outside.

A *surkhi* grinding mill was received and erected in the Minor Forest Products Workshops for grinding charcoal. As a larger horse power motor was required to drive it, the 15 H. P. motor from the Iron Workshops was erected in place of the 7½ H. P. which was fitted in its place in the Iron Workshops.

A log sinking device was made and fitted to the Log Pond at the Saw Mill.

A new centrifugal pump was received and coupled to be driven by a 5 H. P. motor on the same bed. The pump was connected to the suction and delivery pipe lines laid to draw water from the swimming tank and to feed it to the boiler water treatment tanks.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs :—

i. Plant insecticides.

ii. *Derris* spp.

iii. *Tephrosia purpurea* and *T. villosa.*

iv. *Mundulea suberosa.*

v. *Vitex negundo.*

vi. *Strychnos nux-vomica.*

vii. *Myrsine africana.*

viii. *Artemisia* spp.

ix. *Hyoscyamus pussilus.*

B.—Oils and Fats :—

i. *Litsaea zeylanica.*

ii. *Litsaea lanuginosa.*

iii. *Cinnamomum camphora.*

iv. *Melia azedarach.*

v. *Celastrus paniculata.*

C.—Other products :—

i. *Bombax malabaricum.*

2. Study of forest soils.

3. Miscellaneous enquiries :—

i. Fluorescence in wood.

ii. Estimation of arsenic.

I. A.—Drugs.

(i) *Plant insecticides.*—Investigations on plants reputed to act as fish poisons have been continued. Of these, *Derris elliptica, D. malac-*

censis and *Caracca* (*Tephrosia*) *virginiana*, have definitely been established to contain rotenone, the active principle, which is responsible for the insecticidal properties. The other constituents such as deguelin, tephrosin, which are present in these plants in varying quantities, also possess the insecticidal properties but to a lesser degree. In order to form a correct estimate of the insecticidal value of such plants, it is essential, therefore, to take deguelin, etc., also into account and not depend upon the rotenone content alone. Hence it has become the practice now to evaluate all such drugs on the basis of their resin content, namely the ether solubles which contain deguelin, tephrosin, etc., rather than on the rotenone content alone. (Haller and La Forge, J. A. C. S., *56*, 2415.)

Very little is known about the Indian plants which might prove of insecticidal value. The following plants are reputed to act as fish poisons—*Antiaris toxicaria* Lesch; *Barringtonia acutangula* Gaertn; *Casearia graveolens* Dalz.; *Cleistanthus collinus* Benth; *Corypha umbraculifera* Linn; *Cyclamen persicum* Miller; *Derris* spp.; *Diospyros paniculata* Dalz.; *Dolichandrone falcata* Seem; *Entada scandens* Benth; *Eremostachys vicaryi* Benth; *Euphorbia tirucalli* Linn; *Flueggea lencopyrus* Wight.; *Lasiosiphon eriocephalus* Dcne.; *Maesa indica* Wall; *Millettia atropurpurea* Benth; *Mundulea suberosa* Benth; *Myrica nagi*; *Ougeinia dalbergioides*; *Pithecolobium bigeminum* Benth; *Randia dumetorum* Lam.; *Rhododendron barbatum* Wall; *Sapium indi um* Willd.; *Tephrosia* spp.; *Trichilia trifoliata* Roxb.; *Verbascum thapsus* Linn; *Walsura piscidia* Roxb.

Of these, only a few namely *Derris*, *Tephrosias* and *Mundulea suberosa* have been examined. In examination of these plants chemically, more emphasis has been laid on the total ether solubles in the plant than on the rotenone content itself; since a plant, as discussed above, can possess insecticidal value even when no rotenone can be isolated but is otherwise rich in 'resin' content (ether solubles). It is, however, realised that in all cases the final test is the biological assay, nevertheless it can be said that the plants containing the 'resin' constituents and giving the colour test for substances allied to rotenone are likely to prove of insecticidal value. The above criteria have, therefore, been kept in view in examining the following plants.

(ii) *Derris* spp.—It was reported last year that of the several species of *Derris* found in India only *D. elliptica*, collected in Assam, gave rotenone, whilst in all others no rotenone could be isolated and were very poor in ether extracts even though they gave the characteristic colour reaction (Jones and Smith., Ind. and Eng. Chem. Anal. Ed. V. 75). It was also reported that attempts to isolate other crystalline insecticidal bodies allied to rotenone (deguelin, tephrosin, etc.) were unsuccessful.

It was consequently concluded that *D. uliginosa* cannot be considered as an insecticide of much commercial value. Attention was, therefore, concentrated on the examination of *D. elliptica*, further samples of which were obtained from Assam. In this case both the thin roots and the thicker roots were examined, since it is reported elsewhere that the rotenone content varies with the age and the thickness of the roots. The results have been tabulated below and for comparison the results for *D. malaccensis* and *D. elliptica* from Kuala Lumpur (F. M. S.) have also been included. From this it appears that the Indian *D. elliptica*, obtained from Nowgong division, Assam, is of an average quality of commercial insecticides :—

Species.	Locality.	Description.	Moisture air dry powder.	Ether extract.	Carbon tetrachloride.	Rotenone.
			Per cent.	Per cent.	Per cent.	Per cent.
Derris elliptica—						
(i) . .	Lakhimpur division.	Thick roots ¼" to 1½" in diam.	5·3	1·0	..	..
(ii) . .	Ditto .	Thin roots ⅛" to ¼" . in diam.	2·7	1·7	1·4	0·18
Derris elliptica—						
(i) . .	Nowgong division.	Thick roots ⅜" to 1" in diam.	3·8	2·7	..	1·0
(ii) . .	Ditto .	Thin roots ⅛" to ⅜" in diam.	3·5	4·5	..	2·4
Derris elliptica—						
(i) . .	Kuala Lumpur F. Malaya States.	Thick roots ¼" to ⅜" in diam.	4·9	4·5	4·0	0·93
(ii) . .	Ditto .	Thin roots Less than ⅛" in diam.	5·4	3·3	3·3	0·33
Derris malaccensis—						
(i) . .	Kuala Lumpur F. Malaya States.	Thick roots ¼" to ⅜" in diam.	2·5	21·2	19·6	0·78
(ii) . .	Ditto .	Thin roots Less than ⅛" in diam.	10·5	15·5	..	1·2

(iii) *Tephrosia* spp.—The following remarks appeared in the report issued last year " *Tephrosia candida* is an allied species to *Caracca virginiana* found in U. S. America, which has been reported to contain rotenone, deguelin and tephrosin. Roots of *T. candida* growing in the Institute were examined and although 0·9 per cent. of ether extract containing 0·02 per cent. of a crystalline substance m. p. 230°C was isolated no test for rotenone was obtained. It is intended to examine a few more *Tephrosia* species before rejecting it as unfit for insecticidal

purposes." *Tephrosia purpurea* and *T. villosa* have consequently been examined this year and the results are tabulated below.

Species.	Ether solubles.	Rotenone.
T. purpurea—		
roots (thin) a	1·38	*nil.*
b	0·59	,,
twigs a.	0·84	,,
b.	0·69	,,
T. villosa—		
roots	0·95	,,
twigs	0·74	,,
T. candida	0·90	,,

From these it may be concluded that *Tephrosia* spp., hitherto examined, are useless as insecticides.

(iv) *Mundulea suberosa.*—A sample of roots received from Badami range, Southern circle, Bombay, was found to contain 3·8 per cent. of moisture and 4·9 per cent. of ether solubles. Although no rotenone could be isolated, the resins gave the characteristic colour reaction of rotenone and deguelin resins. This species, therefore, although not as good as the Malayan *Derris* is likely to be of some value as an insecticide. The above view, based on the chemical examination alone, is supported by the observation of Tattersfield and Grimingham (Annals of Applied Biology (1932) 19, 253) who found that this species shows a definite activity as a contact insecticide. It would, therefore, be worthwhile to make biological tests on this plant.

(v) *Vitex negundo.*—Preliminary work on the constituents of the leaves of this plant, reported last year, showed that it contained a crystalline polyhydric alcohol m. p. 196°-198°C. Further examination of this substance and its chemical properties support the view that it is a gluco-nonitol. The acid reported to melt at 220°-21°C, on further purification melts at 215°-16°; the drop in its m. p. being due to its contamination with an allied acid of m. p. 285°-87°C. The acid m. p. 215°-16°C forms the main bulk of the free acids and this has now been definitely identified as p. hydroxy benzoic acid, and being an isomer of salicylic acid possesses germicidal properties. The second acid m. p. 184°-85°C reported last year, when further purified by recrystallisation melted at 200°-201°C and its chemical and physical properties indicate

it to be 2 : 5 dioxy benzoic acid. A third acid associated with the acid m. p. 215°-16°C has now been isolated and this like the first acid is sparingly soluble in cold water. It has a melting point of 285°-287°C, sublimes unchanged and from its properties appears to be a hydroxy-isophthalic acid.

Associated with the glucosidal constituent (basic lead acetate precipitate) are two other substances which have not yet been identified and further work on these is in progress. The glucosidal substance itself, however, yields on hydrolysis para-hydroxy benzoic acid and glucose.

(vi) *Strychnos nux-vomica.*—In our previous work on the alkaloidal content of the seeds of *Strychnos* spp. we had overlooked the question of the seasonal variation of the alkaloids in the seeds and this gap in our study has now been filled. The fruits, collected from the same tree but at different time, were obtained from different parts of the Madras Presidency. They were in different stages of ripeness, beginning when the seeds were just embryos and ending when they were fully matured. The analytical results have led to the following observations.

1. Alkaloids are present both in the seeds and the pulp even in the very early stages of their growth.
2. As the seeds ripen the alkaloidal content increases.
3. During the process of ripening the pulp loses its alkaloidal content.
4. The alkaloidal content is highest in December.
5. Once the fruit has opened and the seeds fallen out there is no further change in the alkaloidal content.
6. The proportion of the alkaloid is independent of the size of the seeds. In proportion to their weight the small buttons are as rich in the alkaloidal content as the bigger ones.

These observations are tentative but to confirm them a very much larger number of analyses will have to be made.

(vii) *Myrsine africana.*—During a search for indigenous drugs reputed to be of value as anthelmintics the chemistry of the active constituents of the berries of *M. africana* [vern. *Bebrang* belonging to the family of *Embelia ribes* (N. O. Myrsinacea)] was studied. *E. ribes* also is called *Bebrang* in Hindi and in bazaar no distinction is made in the seeds of the two species, the only apparent difference being that the berries of *E. ribes* are bigger ($\frac{1}{4}''$) than those of the *M. africana.*

The dried berries on extraction gave a crystalline material of golden yellow colour which has been identified as embelic acid, through preparation and identification of its many derivatives. Along with the

colouring matter is deposited a white crystalline substance, specially when the dye is extracted with rectified spirit. The white crystalline substance is insoluble in most of the organic solvents and crystallises out from hot water in prisms m.p. 328°-30°C. This has been identified as d. quercitol.

(viii) *Indian Artemisia.*—It was reported in 1932-33 that the Kurram *Artemisia* cultivated in Dehra Dun divided itself in two sub-forms, the only distinction between the two being that one produced the flower heads early in June while the other did not show any flower heads till late in the year. It was consequently suggested that the one flowering late was the original form and the earlier flowering one was the acclimitised form. The same observation has now been made in the Kashmir *Artemisia.* The Kashmir *Artemisia* has now properly established itself in cultivation and instead of the two forms stated above there is only one form but it flowers twice a year and consequently has two periods of maximum santonine content, namely June and December. The results tabulated below when put on graph show two parallel curves. *viz.*, one from February to July and the other from August to December,

Time of collection, weeks.	Santonine percentage.	Remarks.
4th August 1933	0·60	Leaves only.
4th October 1933 . . .	0·79	Buds only.
1st December 1933 . . .	0·91	Leaves and buds.
1st January 1934	0·78	Ditto.
1st February 1934 . . .	0·12	Ditto.
1st March 1934	0·66	Fresh leaves.
1st April 1934	0·80	Luxuriant growth but no buds.
1st May 1934	0·84	Ditto.
1st June 1934	0·85	Buds making appearance.
3rd June 1934	0·98	Buds.
1st July 1934	0·52	Early rains dropped the buds.
1st August 1934	0·22	Ditto.
4th August 1934	0·62	Fresh young shoots.

(ix) *Hyoscyamus pussilus* Linn.—Perusal of the literature shows that this species has not been worked for its alkaloidal content. A specimen of this collected in Kargil (Kashmir) showed 0·4 per cent. of an alkaloid. According to the British Pharmacopœia the *Hyoscyamus* leaves should not contain under 0·3 per cent. of the total alkaloids

Hyoscyamus or Henbane is one of those plants which thrives very well in Northern India and the alkaloid content increases on cultivation. It is, therefore, encouraging to find a wild species so rich in the alkaloids.

I. B.—Oils and Fats.

The study of the Lauraceae fats has been in progress for the last few years with a view to finding the possible indigenous source of lauric acid. The fat of *Actinodaphne hookeri* as an indigenous source of lauric acid has already been pointed out. In view of the fact that sodium lauryl sulphate is coming into considerable prominence as a base for new detergents, an opportunity is taken to suggest that this and the similarly constituted fats of the *Litsaea* spp. (*N. O. Lauraceae*), over 60 varieties of which are known to be found all over the country, could serve as better raw material for the purpose than the cocoanut and palm kernel oil (trilaurin content under 50 per cent.) employed at present. This is apparent from the high trilaurin content of some of these lauraceae fats, namely *Actinodaphne* 96, *Litsaea sebifera* 96 and *L. lanuginosa* 70 per cent. Recent work on new detergents has shown that the alkali salts of lauryl sulphate possess certain properties which from the point of view as detergents are superior to those possessed by ordinary soaps. For instance, the amount of sodium lauryl sulphate required for washing is practically independent of the hardness of water, whereas the amount of the ordinary soap required to do the same work increases rapidly with the hardness. This is because its calcium and magnesium salts, unlike the calcium and magnesium salts of the fatty acids of high molecular weight are themselves good sudsents and good detergents. Furthermore, sodium lauryl sulphate is not easily affected by salt as ordinary soaps are and performs as well in sea water as in tap water.

This work has now been extended to a few more of the *Litsaea* spp. growing locally and *Litsaea lanuginosa*, *L. zeylanica* and *Cinnamomum camphora* have been investigated during the period under review.

(i) *Litsaea zeylanica* Nees.—Syn. *L. umbrosa* Necs. vern. *Shurur* (Jaunsar), is a moderate sized evergreen tree common in Jaunsar and Tehri Garhwal 4—7,000 ft. The berries yield an oil which is used for burning purposes and is considered by the hill people as a specific for itches and other skin diseases. The berries give 36 per cent. of the oil having the following constants—

Colour	brown
Specific gravity at 25°C	0·9363
Refractive index at 25°C	1·4520
Iodine value (Hanus)	38·3
Saponification value	249·4
Acetyl value	12·7
Hehner value	89·0
Acid value	0·6
Unsaponifiable matter	6·9 per cent.

The *Litsaea zeylanica* fat reported last year had been obtained from the berries received from Bangalore. The present fat has been obtained from the Jaunsar *Litsaeas* and appears to be slightly different in its constituents from the Bangalore species. Work on the isolation and identification of the constituents is in progress.

(ii) *Litsaea lanuginosa* Nees.—It is a moderate sized tree with brown bark found in Dehra Dun, Jaunsar and Tehri Garhwal. The berries gave 94 per cent. of kernels which yielded 38·5 per cent. of a pale yellow oil under hydraulic pressure and a further 13·5 per cent. on solvent extraction. The oil sets hard on cooling and then has a m.p. 37°-38°C and an iodine value of 30. The fat when ground with alcohol loses most of its colouring matter and the unsaturated constituents, giving a nearly colourless fat of iodine value 6·5 and m.p. 41°-44°C. This indicates a large proportion of trilaurin in the fat.

(iii) *Cinnamomum camphora* Linn.—The camphor seeds were collected locally. The oil had the following constants :—

Consistency	Thin
Colour	Yellow
Specific gravity at 25°C	0·9250
Refractive index at 25°C	1·4442
Saponification value	272·3
Iodine value (Hanus)	4·0
Acetyl value	1·8
Hehner value	94·0
Acid value	1·4
Unsaponifiable matter	0·7 per cent.

The work on the isolation and identification of the constituent acid is in progress.

(iv) *Melia azedarach* Linn.—The Persian Lilac.—In view of the reported medicinal value of the leaves, fruit, etc., of this tree and its similarity to the famous *Neem* tree (*Azadirachta indica*) its oil has been examined. The following are the characteristics of the oil :—

Moisture in the kernels	8·2 per cent.
Oil in the kernels	33 per cent.
Colour	Dark brown.
Consistency	Thin.
Optical rotation	*Nil.*
Specific gravity at 25°C	0·9192
Iodine value (Hanus)	135·8
Saponification value	184·3
Acetyl value	33·8
Hehner value	92·0
Acid value	23·4
Unsaponifiable matter	1·9 per cent.

Chemical constants of the mixed fatty acids of the oil—

Mean molecular weight	320·2
Iodine value (Hanus)	65·5
Saturated acids	5·9 per cent.
Unsaturated acids	94·1 „

The oil appears to be a mixture of the glycerides of palmitic, stearic, oleic and linoleic acids. It is a drying oil.

(v) *Celastrus paniculata* Willd.—The oil from its seeds known as the 'Black oil' is used in Ceylon as a nerve stimulant. It has also been reported to be a 'sovereign remedy in Beri-beri'. In view of the reputed medicinal properties of both the oil and the seeds the chemical examination of the kernel oil was undertaken. The data so far collected is reported below :—

Moisture in the kernel	4·3 per cent.
Oil in the kernels by expression	20·5 „
Total oil in the kernels	50·0 „
Colour	Brown.
Specific gravity at 20°C	0·9701
Refractive index at 20°C	1·4693
Saponification value	265·4
Iodine value (Hanus)	94·4
Acid value	25·3

Chemical constants of the mixed fatty acids of the oil—

Mean molecular weight	232·3
Iodine value (Hanus)	99·4
Saturated acids	30·5 per cent.
Unsaturated acids	69·5 „

I. C.—Other products.

Bombax malabaricum.—It is a tree of great economic value since it yields a variety of useful products. An account of this is recorded in the Dictionary of Economic Products of India by Watt, but since that time more information has accumulated regarding the properties and possible uses of *semul* (*B. malabaricum*) which has enhanced its value. In some quarters, however, exaggerated estimates are being put forward regarding its commercial possibilities. It has, therefore, been thought desirable to bring together all the available information regarding these products so that a more correct estimate about their economic value may be formed. Up-to-date information about the wood; the floss (kapok); the seed oil; the seed cake; the gum (*mocharus*) and the roots has been gathered together and incorporated in a paper published in the Indian Forester. The tap root has also been investigated since

the properties of the *semul* root are described in the indigenous system of medicine in glowing terms. The chemical analysis, however, do not fully support the claims made by the Ayurvedic medicine. The only substance that could impart to the root its medicinal property appears to be the phosphatide which it contains. But it is interesting to note that *semul* like the roots of *Asparagus adscendens* and of *Chlorophytum aurendinaceum,* is also highly mucilaginous. It is possible that the mucilage acts as a demulcent tonic.

2. *Forest Soils.*

Black *kallar* soils from Chichawatni (Punjab) and Sindh, seashore soils from the Cochin Harbour, *Usar* soils from the United Provinces have been examined besides the soils from the experimental plots in the Institute.

3. *Miscellaneous Enquiries.*

(i) *Fluorescence of wood under Ultra Violet light.*—It has been known for a long time that aqueous extracts of certain timbers (*Aesculus hippocastanum*, *Fraxinux excelsior*, *Pterocarpus* spp.,etc.) exhibit fluorescence when viewed in sunlight. This phenomena, however, is not general but is restricted only to the extracts or infusions of the bark or wood of certain species, which by themselves seldom show any fluorescence, when viewed in sunlight, and as such was never considered as a definite criterion amongst the physical properties of timber. Fluorescence, which in a large number of substances both organic and inorganic is weak and indefinite in the sunlight is greatly intensified when viewed in Ultra Violet light; and bodies which exhibit little or no fluorescence when viewed in the sunlight begin to show brilliant and often characteristic fluorescence under this light. It is thus a new aid to analytical work. Hitherto, the application of this method to the study of wood has been very scanty and, therefore, an extended study of this subject has been made on Indian timber, using wood blocks, powder and their extracts in common organic solvents. In some of the species the fluorescence is very striking and it is believed that a systematic study of this phenomena, correlating the nature of fluorescence with constituents of timber and its anatomical structure may prove of value as an aid to identification.

More than a hundred specimen of Indian timbers have been examined and most of these have been found to fluoresce under ultra violet light. Different woods showed different fluorescence, the colour ranging from snuff brown to violet with practically all shades of orange, yellow, green, blue and indigo between these extremes. Intensity of fluorescence, however, is not restricted to any particular part of the wood. In some

cases the heartwood fluoresces more brilliantly than the sapwood, and in others reverse is the case. Then again, in many cases the colour of fluorescence in sapwood and heartwood is altogether different. The colour of fluorescence exhibited by wood blocks and wood powder was more or less identical but, in many cases, the extract shows a different fluorescence.

The colour and nature of fluorescence exhibited by a timber is apparently dependent upon the proportion and distribution of its constituents, such as starch, colouring matter, gums, resins, etc., and it has already been noted by different workers that these constituents show different fluorescence under ultra violet light. For instance, starch gives a blue fluorescence, colouring matter a yellow, resins orange and so on. The study of fluorescence of wood under ultra violet light has thus opened up the possibilities of locating these substances in different parts of the wood. To extend this study efforts were made to locate the constituents which are responsible for fluorescence in *Albizzia lebbek*. Heartwood of this species shows bright orange colour alternate with reddish brown rings and the sapwood light blue. For examination, a section ($3'' \times 1\frac{1}{2}'' \times \frac{1}{4}''$) containing both the heartwood and the sapwood was cut and successively extracted with petroleum ether, sulphuric ether, chloroform, acetone, rectified spirit and finally with water. After each extraction, the piece was dried in vacuum and studied under ultra violet light alongside the comparison block to notice if any change in the colour and depth of the fluorescence had been produced due to the loss of any of its constituents, by the solvent. Petroleum ether, sulphuric ether and chloroform produced no effect, but acetone and alcohol removed the orange colouring matter. That is to say after complete extraction with rectified spirit the orange rings disappeared altogether and the solvent began to show deep orange fluorescence. The blue colour still remained but this was more or less completely removed by extraction with boiling water, thus showing the carbohydrate nature of the deposit.

In trying to differentiate between *Dipterocarpus tuberculatus* and other varieties of *Dipterocarpus* with the help of ultra violet light it was noticed that freshly cut surface of the former showed a distinct blue violet fluorescence whereas the other varieties showed little or no such fluorescence. All the specimen examined, however, were old and dry. Recently a freshly cut green log of *Dipterocarpus tuberculatus*, which had been exuding a large quantity of oleoresin, was examined under ultra violet light. It was observed that the entire surface of the wood showed the characteristic blue-violet fluorescence and the oleoresin also showed the same fluorescence. From this there is ground to believe that the oleoresin is responsible for the characteristic fluorescence of *Dipterocarpus tuberculatus*. Since the other varieties of *Dip-*

terocarpus contain very much less of oleoresin, they show comparatively feeble or no fluorescence.

(ii) *Estimation of arsenic in wood.*—It is well known that the estimation of very small quantity of arsenic is best made by the Berzelius Marsh Method, but it has been noticed that this method is not of general application especially when arsenic is to be determined in presence of copper and oxidising agents. In work on the determination of arsenic (of the order of 0·005 per cent.) in wood treated with arsenic copper salt solutions, this difficulty was felt and it was noticed that in certain cases the results were deflected by as much as 50 per cent. This led to the search for factors that might be responsible for this deflection. The first thing looked for was the possible disturbance due to the presence of the oxidising agents, such as pottassium dichromate which is present in the wood preserving salts or the nitric acid and the oxides of nitrogen which are left over when the wood is digested with this acid for analysis and the complete removal of which is a lengthy and tedious affair. The second factor responsible for the low arsenic result was found in copper sulphate which is present in the mixture. From this it was concluded that Marsh's method cannot be followed to get accurate results in such cases and reference to the chemical literature on the subject indicated that such conclusions were correct. It was, therefore, attempted to determine the best method for the estimation of arsenic when present along with copper salts and oxidising agents. Several well-known methods were tried and the standard sulphide method, with slight modifications to suit our purpose, was decided upon. This method with a little care can give results of an accuracy of 0·5 per cent. error.

Miscellaneous Enquiries.

A large number of analyses of various substances were undertaken on behalf of the officers of the Institute and the forest officers. Particular mention may be made of the following :—

Casein Cements, Glues, Sandal wood oil, Rosha grass oil, drugs and tannin materials.

APPENDIX I.

Publications of 1934-35.

Serial No.	Title of Publication.	Author.	Date of issue.
	FOREST RECORDS.		
1	Entomological Investigations on the Spike Disease of Sandal (23) Anthicidae.	R. F. Heberdey .	June 1934.
2	Methods of Testing the Susceptibility of Timbers to Termite Attack.	C. Dover and R. N. Mathur.	August 1934.
3	Immatures Stages of Indian Coleoptera (15) (Scolytidae).	J. C. M. Gardner .	August 1934.
4	Entomological Investigations on the Spike Disease of Sandal (24) Pentatomidae.	N. C. Chatterjee .	August 1934.
5	Sur Quelques Longicornes Des Indes (Cerambycidae).	N. N. Plavilstshikov	August 1934.
6	New Termites from India.	T. E. Snyder . .	September 1934.
7	New Ichneumonidae from India and China .	R. A. Cushman .	December 1934.
8	Results of Experiments on the Kiln drying of Wood with Ozonized Air.	S. N. Kapur . .	March 1935.
9	Interim Report on Work under Project VIII.—Testing of Indian Timbers for Veneer and Plywood.	W. Nagle . .	December 1934.
10	A Stand Table for Sal evenaged High Forest and Coppice.	....	(May 1935.)
11	Illustrations of Indian Forest Plants, Part III .	R. N. Parker and C. E. Parkinson.	(June 1935.)
12	Immature Stages of Indian Coleoptera (16) (Scarabaeidae).	J. C. M. Gardner .	(September 1935.)
13	Immature Stages of Indian Coleoptera (17) (Eucnemidae).	J. C. M. Gardner .	(Do.)
14	On the Biology of Psyllidae	R. N. Mathur. .	(Do.)
15	Neue Brenthiden und Lyciden aus Indien . .	R. Kleine . .	(Do.)
16	Neue Attelabiden aus Indien (Curculionidae Col.)	Eduard Voss . .	(October 1935.)
17	Biology of Braconidae (Hymenoptera) . .	C. F. C. Beeson and S. N. Chatterjee.	(*In Press.*)
18	Preliminary Survey of the Forest Types of India and Burma.	H. G. Champion .	(*In Press.*)
19	A Study of the Soils in the Hill areas of Kulu Forest Division, Part I.—An Investigation of Soil Profiles under Deodar, Spruce, Blue Pine and Chir.	E. McKenzie Taylor, I. D. Mahendru, M. L. Mehta and R. C. Hoon.	(*In Press.*)
	FOREST BULLETINS.		
20	A Record of the Results obtained with Experimental Treated Sleepers laid in the Indian Railways between 1911 and 1916.	S. Kamesam . .	October 1934.
21	Cold Weather Planting in Northern India . .	H. G. Champion .	September 1934.
22	Yield Tables for Teak Plantations in Java . .	H. G. Champion .	January 1935.
23	Seasonal Progress of Height Growth in Trees .	H. G. Champion .	March 1935.
24	Effect of Defoliation on the Increment of Teak Saplings.	H. G. Champion .	January 1935.
25	Official List of Trade Names of Indian Timbers .	....	(July 1935.)
26	Damage by Frost at New Forest, Dehra Dun .	Bachaspati Nautiyal	(September 1935.)

APPENDIX I—*contd.*

Serial No.	Title of Publication.	Author.	Date of issue.
	OTHER PUBLICATIONS.		
27	Forest Research in India, 1933-34, Part I.—The Forest Research Institute.	....	October 1934.
28	Forest Research in India, 1933-34, Part II.—The Provincial Reports.	....	March 1935.
29	Classified List of Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India and Burma on the 1st July 1934.	....	December 1934.
30	Manual on the Air Seasoning of Indian Timbers .	S. N. Kapur . .	December 1934.

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS.

Silviculture.

Gorrie, R. M. . . . Life in Forest Soils (*Indian Forester*, April 1934).
Gorrie, R. M. . . . Measurement of Soil Fertility (*Indian Forester*, May 1934).
Trevor, C. G. . . . Hydrogen ion concentration in Forest Soils (*Indian Forester*, July 1934).
Champion, H. G. . . Tour Jottings from South Bengal (*Indian Forester*, July 1934).
Champion, H. G. . . Artificial Regeneration of Tropical evergreen forests in South Bengal (*Indian Forester*, August 1934).
Champion, H. G. . . Test of the Precision of the Standard Indian Sample Plot Methods (*Indian Forester*, October 1934).
Nautiyal, Bachaspati . . Use of Paper Tubes in Planting Work (*Indian Forester*, January 1935).
Kakazai, M. A. . . . Protecting Naini Tal from landslips by Reclamation of Denuded Hill Slopes (*Indian Forester*, January 1935).
Champion, H. G. . . Tour Jottings in Madras (*Indian Forester*, March 1935).

Entomology.

—— Rat Damage in North-West Frontier Province Forest (*Indian Forester*, July 1934).
Beeson, C. F. C. . . . Role of Insects in the dying-off of Sal (*Indian Forester*, August 1934).
Beeson, C. F. C. . . . Biological control of Teak Defoliators (*Indian Forester*, October 1934).
Gardner, J. C. M. . . A new Indian Species of *Atractocerous* (Col. Lymexylonidae). (*Stylops*, Vol. 4, Pt. 3, 1935, pp. 69-70).
Gardner, J. C. M. . . On some Coleopterous Larvae from Uganda. (*Bulletin Entomological Research*, Vol. 25, 1934, pp. 149-53).

Botany.

Parkinson, C. E. . . . On a Botanical Visit to Mulayit Peak (*Indian Forester*, April 1934).
Trevor, C. G. . . . Cupressus cashmeriana (*Indian Forester*, July 1934 and October 1934).
Mukat Behari Raizada . New or little known plants from Kumaon (*Indian Forester*, August 1934).
Trevor, C. G. . . . *Eucalyptus naudiniana* (*Indian Forester*, September 1934).

Economic.

Narayanamurti, D. . .	Notes on German Developments in Wood Utilization. Durability Tests on untreated Indian Timbers.
Seaman, L. N. . . .	New Method of Piling Railway Sleepers (*Indian Forester*, July 1934).
Kapur, S. N. . . .	Interim Report on the air-seasoning experiment on Softwood Sleepers at Dhilwan (*Indian Forester*, July 1934).
Azizul Rehman . . .	Radius cutting as a method of seasoning logs (*Indian Forester*, August 1934).
Kapur, S. N. . . .	Results obtained with kiln drying of laurel according to new method (*Indian Forester*, August 1934).
Chowdhury, K. A. . .	A defective log of *Papita* from the Andamans (*Indian Forester*, September 1934).
Seaman, L. N. . . .	Wooden Bearings (*Indian Forester*, September 1934).
Trevor, C. G. . . .	Changa Manga mulberry and English ash (*Indian Forester*, October 1934).
Kapur, S. N. and Narayanamurti, D.	Hygroscopicity of Tree Barks (*Indian Forester*, October 1934).
Ramaswami, S. . . .	Forest Research Institute Portable Charcoal Kiln (*Indian Forester*, January 1935).
Chowdhury, K. A. . .	A fossil dicotyledonous wood from Assam. (*Current Science*, December 1934).
Kapur, S. N. . . .	An improved method for kiln drying green hardwoods. (*Hardwood Record*, March 1935).
Kapur, S. N. and Narayanamurti, D.	A simple air-conditioning chamber for laboratory experiments. (*Current Science*, June 1934).

Chemistry.

Puntambekar, S. V. . .	Pyrethrum (*Indian Forester*, April 1934).
Puntambekar, S. V. . .	*Actinodaphne* and *Litsaea* fats as raw material for a valuable new detergent (*Indian Forester*, October 1934).
Puntambekar, S. V. and Varma, B. S.	Utilization of Indian Acorns (*Indian Forester*, November 1934).
Ghose, T. P. . . .	*Bombax malabaricum* (*Indian Forester*, February 1935).
Puntambekar, S. V. and Krishna, S.	Some Indian Acorn Oils (*Quercus incana*, Roxb., *Q. dilatata*, Lindl., and *Q. ilex*, Linn). (*Jour. Ind. Chem. Soc.* 1934, p. 721).
Puntambekar, S. V. and Krishna, S.	*Actinodaphne* Fat as a parent material for a new detergent. (*Jour. Ind. Chem. Soc.* 1934, p. 711).
Krishna, S. and Chowdhury, K. A.	Fluorescence in Wood under Ultra Violet Light (*Current Science*, 1934, p. 65).
Ghose, T. P., Krishna, S. and Schlittler, E.	The Constitution of Actinodaphnine. (*Hel. Chim. Acta*, 1934, p. 919).

APPENDIX II.

PUBLICATIONS OF THE FOREST RESEARCH INSTITUTE, DEHRA DUN, AVAILABLE FOR SALE.

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APPENDIX III.

Statement showing Officers-in-charge of Branches and Sections during the year 1934-35.

Branch.	Officer-in-Charge.	Section.	Officer-in-Charge.	From	To
Silviculture .	Mr. H. G. Champion, Silviculturist.	..	..	1-4-1934	13-11-1934
				21-2-1935	31-3-1935
		Experimental .	Mr. P. N. Deogun	1-4-1934	17-11-1934
		Statistical .	Mr. M. A. Kakazai	1-4-1934	31-3-1935
Botany .	Mr. C. E. Parkinson, Forest Botanist.	..	..	1-4-1934	31-3-1935
		Mycology .	Dr. K. D. Bagchee	1-4-1934	8-8-1934
			Dr. K. D. Bagchee	24-8-1934	31-3-1935
Economic .	Capt. H. Trotter, Forest Economist.	..	..	1-4-1934	7-2-1935
	(Mr. W. A. Bailey)	..	..	8-2-1935	31-3-1935
		Minor Forest Products.	Capt. H. Trotter .	1-4-1934	7-2-1935
			(Mr. W. A. Bailey)	8-2-1935	31-3-1935
		Timber Testing.	Mr. L. N. Seaman	1-4-1934	5-3-1935
			(Mr. V. D. Limaye)	6-3-1935	31-3-1935
		Wood Preservation.	Mr. S. Kamesam .	1-4-1934	23-9-1934
			(Capt. H. Trotter)	24-9-1934	21-10-1934
			Mr. S. Kamesam .	22-10-1934	31-3-1935
		Seasoning .	Dr. S. N. Kapur .	1-4-1934	22-12-1934
			(Mr. A. Rehman) .	23-12-1934	6-2-1935
			Dr. S. N. Kapur .	7-2-1935	31-3-1935
		Paper Pulp .	Mr. M. P. Bhargava	1-4-1934	31-3-1935
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1934	31-3-1935
		Wood Workshop	(Capt. H. Trotter)	1-4-1934	2-11-1934
			Mr. W. Nagle .	3-11-1934	31-3-1935
Entomology .	Dr. C. F. C. Beeson, Forest Entomologist.	..	..	1-4-1934	10-7-1934
	(Mr. J. C. M. Gardner).	..	..	11-7-1934	25-10-1934
	Dr. C. F. C. Beeson	..	..	26-10-1934	31-3-1935
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1934	31-3-1935
Bio-chemistry	Dr. S. Krishna, Bio-chemist.	..	..	1-4-1934	31-3-1935

APPENDIX IV.

ANNUAL FORM NO. 24.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure during 1934-35.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
REVENUE.							
V.—Miscellaneous—							
(*b*) Other sources . .	512	359	65	74	3,140	..	4,150
(*d*) Sale of timber and furniture from Seasoning and Wood Workshop Depot.	..	..	..	..	481	..	481
Total Revenue .	512	359	65	74	3,621	..	4,631
EXPENDITURE.							
A.—Conservancy, Maintenance and Regeneration—							
C. 1.—Purchase of stores, tools and plant.	527	311	975	122	5,835	13	7,783
C. 2.—Communications and Buildings, Repairs and Maintenance.	279	..	..	..	..	..	279
C. 3.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	4,911	1,502	3,837	2,370	2,097	421	15,804
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	5,040	..	5,040
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	73	10,524	1,586	12,183
(4) Other charges .	99	2,757	1,772	735	14,459	235	20,057
Total A.—Conservancy, Maintenance and Regeneration.	5,816	4,630	6,584	3,306	39,155	2,255	61,746

APPENDIX IV—*contd.*

ANNUAL FORM NO. 24—*contd.*

FOREST RESEARCH INSTITUTE—*contd.*

Summary of Revenue and Expenditure during 1934-35—contd.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*contd.*							
B.—Establishments—							
I.—Pay of officers—							
Non-voted—							
(*b*) Superior officers.	13,211	11,436	..	26,496	17,708	..	68,851
Voted—							
Superior officers .	760	12,250	30,610	12,045	1,04,281	22,234	1,82,180
II.—Pay of Establishment.	33,568	20,952	10,717	24,578	95,937	4,761	1,90,513
III.—Allowances—							
(*b*) House-rent and other allowances—							
Voted . . .	652	..	..	..	..	..	652
Travelling allowances—							
(*d*) Superior officers—							
Non-voted . .	180	976	..	1,876	213	..	3,245
Voted . . .							
(*e*) Subordinate forest and depot establishments.	1,935	1,058	2,801	3,526	7,268	221	17,409
(*f*) Office Establishments							
IV.—Contingencies—							
(*a*) Stationery . .	36	600	42	..	5	..	683
(*b*) Carriage of records and tents.	302	191	631	1,041	42	..	2,207
(*c*) Rents, rates and taxes	10,519	121	384	2	22	..	11,048
(*d*) Pay of menials .	..	..	..	..	..	..	..
(*e*) Official postage .	840	300	330	362	328	62	2,222
(*f*) Sundries . .	11,627	532	615	1,530	1,905	842	18,913*
(*g*) Clothing and uniform	374	86	37	154	297	47	995
(*h*) Telephone . .	1,155	294	320	399	1,548	256	3,972

APPENDIX IV—*concld.*

ANNUAL FORM No. 24—*concld.*

FOREST RESEARCH INSTITUTE—*concld.*

Summary of Revenue and Expenditure during 1934-35—concld.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*concld.*							
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-Voted.)	4,288	436	..	1,200	600	..	6,524
Total B.—Establishments	79,447	40,832	46,487	73,209	2,30,154	28,423	5,09,414*
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	85,263	54,462	53,071	76,515	2,09,309	30,678	5,71,160*
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	..	..	..	568	421	..	989
Surplus or deficit . .	—84,751	—54,103	—53,006	—77,009	—2,66,109	—30,678	—5,07,518*

* Details for the distribution of Rs. 1,862 included in these figures on account of publications through High Commissioner are being obtained from the Accountant General, Central Revenues, New Delhi.

NOTE.—The figures given in this statement have been prepared in the President's Office and are based on the Summary of Revenue and Expenditure for March 1935 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items.

C. G. TREVOR,

President,

Forest Research Institute and College.

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